समाचार पत्रिका

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Editorial

The Editorial Board is happy to publish this News Bulletin (Volume 18) of Nepal Geological Society. On the occasion of Happy New Year 2058 B. S., we express best wishes to all the members and well-wishers of the Nepal Geological Society.

This Bulletin summarises the last year's achievements and activities of the Nepal Geological Society. It also includes the abstracts and papers presented in the Workshop on Himalayan Uplift and Palaeoclimatic Changes in Central Nepal. The Workshop was jointly organised by the Nepal Geological Society; Integrated Studies on Himalayan Uplift and Climate Change Project, Japan; Palaeo-Kathmandu Lake Project, Japan; Central Department of Geology, Tribhuvan University, Kathmandu, Nepal; and Department of Geology, Tri-Chandra Campus, Tribhuvan University, Kathmandu, Nepal.

The Nepal Geological Society is going to organise **the Third Nepal Geological Congress** from 26 to 28 September 2001 in Kathmandu. We welcome all the delegates of the Congress and express our hearty felicitations and best wishes to them. We are certain that the Third Congress will be an august gathering of geoscientist from various parts of the world and will provide an ample opportunity to share ideas and knowledge among the participants of the Congress.

We thank all the persons and institutions who helped in collecting information and publishing this Bulletin. On behalf of the Nepal Geological Society, we sincerely express our gratitude to the organisations and agencies who helped the Society by providing financial support and giving advertisements in the Bulletin.

We also expect to get your valuable comments and suggestions on improving the Bulletin and Journal of Nepal Geological Society.

Thank you.

– M. R. D., K. P. K., B. M. J., V. C. T., A. A. B

LIST OF PUBLICATION OF NEPAL GEOLOGICAL SOCIETY

1. Journal of Nepal Geological Society, Vol. 23 (in Press)
2. Journal of Nepal Geological Society, Vol. 22 (**Special Issue**), Dec. 2000
   (Proceedings of ***International Symposium on Engineering Geology, Hydrogeology, and Natural Disasters with Emphasis on Asia,*** 28-30 September 1999, Kathmandu, Nepal)
3. Journal of Nepal Geological Society, Vol. 21, 2000
4. Journal of Nepal Geological Society, Vol. 20 (**Special Issue**), 1999
   (Abstract Volume of Symposium, September 1999)
5. Journal of Nepal Geological Society, Vol. 19, 1999
6. Journal of Nepal Geological Society, Vol. 18 (**Special Issue**), 1998
   (Proceedings of Second Nepal Geological Congress,1995)
7. Journal of Nepal Geological Society ,Vol. 17, 1997
8. Journal of Nepal Geological Society, Vol. 16 (**Special Issue**), 1997
   (Abstract Volume of Second Nepal Geological Society)
9. Journal of Nepal Geological Society, Vol. 15, 1997
10. Journal of Nepal Geological Society, Vol. 14 (**Special Issue**), 1996
    (Proceedings of First Nepal Geological Congress,1995)
11. Journal of Nepal Geological Society, Vol. 13, 1996
12. Journal of Nepal Geological Society, Vol. 12 (**Special Issue**), 1995
    (Abstract Volume of First Nepal Geological Congress 1995)
13. Journal of Nepal Geological Society, Vol. 11 (**Special Issue**), 1995
    (Proceedings of 9th Himalaya – Karakoram –Tibet Workshop, 1994)
14. Journal of Nepal Geological Society, Vol. 10, 1995
15. Journal of Nepal Geological Society, Vol. 10 (**Special Issue**), 1994
    (Abstract of 9th Himalaya – Karakoram –Tibet Workshop, 1994)
16. Journal of Nepal Geological Society, Vol. 9, 1993 (50% discount price)
17. Journal of Nepal Geological Society, Vol. 8, 1992 (")
18. Journal of Nepal Geological Society, Vol. 7, 1991 (")
19. Journal of Nepal Geological Society, Vol. 7 (**Special Issue**), 1991 (")
20. Journal of Nepal Geological Society, Vol. 6, 1989 (")
21. Journal of Nepal Geological Society, Vol. 5, No.1, 1988 (")
22. Journal of Nepal Geological Society, Vol. 4, Nos.1 and 2,1987 (")
23. Journal of Nepal Geological Society, Vol. 4, (**Special Issue**), 1994*
24. Journal of Nepal Geological Society, Vol. 3, Nos. 1 and 2, 1985 (")
25. Journal of Nepal Geological Society, Vol. 2, No. 2 1983 (")
26. Journal of Nepal Geological Society, Vol. 2 (**Special Issue**), 1982*
27. Journal of Nepal Geological Society, Vol. 2, No. 1, 1981 (")
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NGS News

The Nepal Geological Society published the **Proceedings of International Symposium on Engineering Geology, Hydrogeology, and Natural Disasters with Emphasis on Asia** as a Special Issue of the Journal of Nepal Geological Society, Volume 22. Publication of the Journal of Nepal Geological Society, Volume 23 is in progress.

The 21st Annual General Body Meeting of the Nepal Geological Society (NGS) was held on 31 August 2000 (15 Bhadra 2057 B. S.) in the auditorium of Department of Mines and Geology, Lainchaur, Kathmandu. The meeting was conducted under the Chairmanship of Mr. R. K. Aryal, President, NGS. The meeting was attended by most of its members and was held in a friendly and lively atmosphere.

The meeting was proceeded with the welcome speech of Mr. R. K. Aryal, President. It was followed by the presentation of the Annual Report by Mr. U. B. Shrestha, General Secretary. Mr. Shrestha highlighted mainly on the activities of NGS in the last one year and about the programmes for the coming fiscal year. After that, Mr. Arjun Aryal, Treasure of the Society presented the Annual Financial Report (Status) of 2056/057. It was followed by the discussion on various topics. There was wide participation of the members in the discussions on various issues raised by the members. Some important decisions were also made at the meeting after the discussions.

The General Body meeting of NGS decided to honour the following two distinguished geoscientists: Professor Dr. K. S. Validya from the Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, India; and Dr. Patrick Le Fort from France on recognition of their substantial contribution to the Himalayan geology.

The representation of NGS is being continued as in the past in various meetings, workshops, seminars, and conferences organised by various governmental and non-governmental organisations and agencies.

The Nepal Geological Society together with the Integrated Studies on Himalayan Uplift and Climate Change Project, Japan; Palaeo-Kathmandu Lake Project, Japan; Central Department of Geology, Tribhuvan University; and Deparment of Geology, Tri-Chandra Campus, Tribhuvan University jointly organised the one–day workshop on **Himalayan Uplift and Palaeoclimatic Change in Central Nepal** on 10 November 2000 in Kathmandu.

The Nepal Geological Society organised four **geoscientific talk programmes** by national and international geoscientists on various topics in 2000/2001.

The Nepal Geological Society is going to organise the **Third Nepal Geological Congress** on 26–28 September 2001 in Kathmandu. So far about 200 geo-scientists from 12 countries have already shown their interest to take part in this Congress. More than 300 participants are expected to take part in the Congress. All the NGS members are requested to take part in the above Congress and present the findings of their research works.

The representation of NGS is being made as in the past, in various seminars, workshops, and meetings organised by various national and international governmental and non-governmental organisations, and societies.

21st GENERAL BODY MEETING OF NEPAL GEOLOGICAL SOCIETY
नेपाल भौगर्भिक समाजको एक्काइसौं वार्षिक साधारण सभा

The 21st Annual General Body Meeting of the Nepal Geological Society was held in the Auditorium of the Department of Mines and Geology, Lainchaur, Kathmandu, Nepal on 31 August 2001 (15 Bhadra 2057 B. S.). The meeting was conducted under the chairmanship of Mr. R. K. Aryal, President, Nepal Geological Society (नेपाल भौगर्भिक समाजको एक्काइसौं साधारण सभा गत भाद्र १५ गते २०५७ तदनुसार ३१ अगस्त २००० का दिन काठमाडौं, लैनचौर स्थित खानी तथा भूगर्भ विभागको सभाकक्षमा समाजका अध्यक्ष श्री रमेश कुमार अर्यालको अध्यक्षतामा सुसम्पन्न भएको थियो ।)

उक्त अवसरमा सर्वप्रथम समाजका अध्यक्ष श्री रमेश कुमार अर्यालले उपस्थित समाजका सम्पूर्ण सदस्यहरुलाई स्वागत गर्दै आफ्नो स्वागत भाषण प्रस्तुत गर्नुका साथै गत वर्षमा यस समाजले गरेका मुख्य मुख्य कार्यक्रमहरु र अब आउने दिनहरुमा गरिने कृयाकलापहरू जस्तै

- International Symposium on Engineering geology, Hydrogeology, and Natural Disasters with Emphasis on Asia को सफल आयोजना;
- श्री ५ महाराजाधिराज सरकारबाट सो को समुद्घाटन;
- Scientific Talk Programme को आयोजना;
- विभिन्न संघ-संस्थाहरुबाट विभिन्न कार्यक्रममा भाग लिन निमन्त्रणा आए अनुसार सो कार्यक्रममा सहभागिता;
- Publication of Bulletin Vol. 17 and Journals Vol. 21 and 22;
- Observation of International Safety Day (ISDR);
- Honorary Membership प्रदान गर्ने बारे कमिटीको निर्णय बारेमा संक्षिप्त प्रकाश पार्नुका साथै आउँदो सेप्टेम्बर मा the Third Nepal Geological Congress को आयोजना गर्ने सम्बन्धमा सदस्यहरुको राय पाउन आग्रह गर्नुभयो ।

गत वर्ष समाजले IAEG को सहयोगमा आयोजना गरेको International Symposium को समुद्घाटन श्री ५ महाराजाधिराज वीरेन्द्र वीर विक्रम शाहदेव सरकारका बाहुलिबाट सुसम्पन्न भएको र उक्त अवसरमा श्री ५ बडामहारानी ऐश्वर्य राज्य लक्ष्मी देवी शाह पनि सवारी भइबक्सेकोमा यस समाजको तर्फबाट मौसुफहरु प्रति पुनः एक पटक हार्दिक कृतज्ञता ज्ञापन गर्नुभयो ।

तत्पश्चात्, यस समाजका महासचिव श्री उत्तम बोल श्रेष्ठले समाजको वार्षिक प्रतिवेदन प्रस्तुत गर्नुभयो । उक्त अवसरमा श्री श्रेष्ठले विगतमा नेपाल भौगर्भिक समाजले गरेका तथा भविष्यमा संचालन गरिने कार्यक्रमहरुको विवरण दिनुका साथै आउँदो सेप्टेम्बर २००१ मा आयोजना गर्न लागिएको the Third Nepal Geological Congress लाई सफल पार्न गत वर्षहरुमा जस्तै यस पटक पनि सम्पूर्ण साथीहरुसँग सहयोगको अपेक्षा गर्नुभयो । उक्त अवसरमा उहाँले हालसम्म नेपाल भौगर्भिक समाजको सदस्य सङ्ख्या ४५२ र एसोसियट सदस्य सङ्ख्या २० गरी जम्मा ४७२ भएको कुरा जानकारी गराउनुभयो ।

यस पछि कार्यक्रमलाई अगाडि बढाउने क्रममा उक्त समाजका कोषाध्यक्ष श्री अर्जुन अर्यालले समाजको गत आ. व. २०५६।५७ को आय-व्यय विवरण प्रस्तुत गर्नुका साथै लेखा परीक्षणको विवरण समेत प्रस्तुत गर्नुभयो ।

तत्पश्चात् पूर्वघोषित कार्यक्रम अनुसारका विषयमा खुँदागत छलफल गरी समाजका सदस्यहरुले विभिन्न विषयमा उठाएका प्रश्नहरुमा पनि विस्तृत छलफल भएको थियो। उक्त अवसरमा प्रस्तुत गरिएका स्वागत भाषण एवं प्रतिवेदन र विभिन्न समसामयिक विषयमा उठेका प्रश्नहरु एवं हरेक खुँदामा भएको छलफल र जवाफहरु एवं निर्णयहरु तल प्रस्तुत गरिएका छन् ।

नेपाल भौगर्भिक समाजका अध्यक्ष श्री रमेश कुमार अर्यालबाट २१औं साधारण सभामा प्रस्तुत स्वागत भाषण (Welcome Speech by Mr. R. K. Aryal, President, Nepal Geological Society, on the occasion of 21st General Body Meeting)

सम्मानित सदस्यज्यू,
भूतपूर्व सभापतिज्युहरू,
समाजका आदरणीय सदस्यज्युहरू,

सर्वप्रथम म नेपाल भौगर्भिक समाजले आयोजना गरेको आजको २१औं साधारण सभामा उपस्थित सम्पूर्ण सदस्य साथीहरुलाई दशौं कार्यकारिणी समितिको तर्फबाट हार्दिक अभिवादनका साथै यस सभामा हार्दिक स्वागत गर्दछु।

आदरणीय सदस्य साथीहरु, यस का. का. स. ले आफ्नो ३ वर्षे कार्यकालको दुई वर्षको अवधि पूरा गरिसकेको छ। वितेका दुई वर्षको अवधि मध्ये १ वर्षे कार्यकालको प्रगति २०औं साधारण सभामा प्रस्तुत गइसकेको तथा त्यस उप्रान्तको १ वर्ष अवधिमा यस का. का. स. ले समय समयमा सम्पन्न गरेका विभिन्न कार्यक्रम तथा तिनको सफल कार्यान्वयन बारेको विस्तृत प्रतिवेदन दशौं का. का. स. का तर्फबाट महासचिव श्री उत्तमबोल श्रेष्ठले प्रस्तुत गर्नु हुने छ भने कोषाध्यक्ष श्री अर्जुन अर्यालले समाजको वार्षिक आय-व्ययको विवरण पेश गर्नुहुनेछ।

गत दुई वर्षको कार्यकालमा हामीले सम्पन्न गरेका विभिन्न कार्यक्रम मध्ये September 1999 मा IAEG तथा अन्य संस्थाको संयुक्त तत्वाधानमा सम्पन्न गरेका International Symposium on Engineering, Geology, Hydrogeology, and Natural Disasters with Emphasis on ASIA, 28-30 September काठमाडौंमा आयोजना गरी सफलताका साथ सम्पन्न गरेको हुँदा समाजको प्रतिष्ठा राष्ट्रिय तथा अन्तर्राष्ट्रिय स्तरमा बढेको महसुस गरेको छु।

यस अन्तर्राष्ट्रिय स्तरको सम्मेलनको समुद्घाटन श्री ५ महाराजाधिराज वीरेन्द्र वीर विक्रम शाहदेव सरकार का बाहुलीबाट सुसम्पन्न गरिबक्सेको थियो र साथै उक्त समारोहमा श्री ५ बडामहारानी सरकार समुपस्थित होइबक्सी यस समाजको गरिमा तथा भूवैज्ञानिकहरूको प्रतिष्ठा र हैसला बढाइबक्सेकोमा यो समाज श्रीमुफ सरकारहरुमा हार्दिक कृतज्ञता ज्ञापन गर्दछु।

अन्तर्राष्ट्रिय सम्मेलनको आयोजना सफलतापूर्वक सम्पन्न गर्ने कार्यमा समाजका सम्पूर्ण सदस्यहरूको सहयोग तथा सहभागिताको लागि आभार प्रकट गर्दै धन्यवाद ज्ञापन गर्दछु।

सदा भै यो कार्यकारिणी समिति समाजका सदस्य साथीहरुबाट समाजको उन्नति तथा प्रगतिको लागि विगत जस्तै महत्वपूर्ण सुझाव, सल्लाह र सहयोगको अपेक्षा राख्दछ।

अब म आफ्नो मन्तव्य पूरा गर्दै अन्य विषय प्रवेशको लागि अरू साथीहरूलाई आमन्त्रित गर्दछु।

धन्यवाद।

नेपाल भौगर्भिक समाजका महासचिव श्री उत्तम बोल श्रेष्ठबाट २१औं साधारण सभामा प्रस्तुत वार्षिक प्रतिवेदन (Annual Report presented by Mr. U. B. Shrestha, General Secretary, NGS, on the occasion of 21st General Body Meeting)

Mr. Chairman,
Former Presidents,
Honorary Members,
Respected Members of the Society,

It gives me a great pleasure to welcome you all to the 21st Annual General Body Meeting of the Nepal Geological Society, on behalf of the 10th Executive Committee and myself in person. We have already passed two years since we took the responsibility of prestigious office of the Nepal Geological Society. During the period we have been putting our efforts to the extent possible to enhance the activities of the Society and fulfil its objectives. In this context, dear respected members, firstly I would like to inform you about the major works completed during the year and then to inform about the planned activities to be undertaken in the coming year.

The different works completed during the last one year tenure were:

International Symposium

I feel proud to inform you that the Society has organised the **International Symposium on Engineering Geology, Hydrogeology, and Natural Disasters with Emphasis on Asia** from 28 to 30 September 1999. We are very grateful to **His Majesty King Birendra Bir Bikram Shah Dev** for graciously inaugurating the ceremony and **Her Majesty the Queen** for graciously observing the occasion. This

Symposium was organised under the sponsorship of the International Association for Engineering Geology and the Environment (IAEG) and endorsed by the International Decade for Natural Disaster Reduction (IDNDR) Secretariat, Geneva, Switzerland; CO-GEOENVIRONMENT (IUGS); and also in association with various national and international organisations.

On the occasion, His Majesty conferred upon the Honorary Membership of the Nepal Geological Society to the two distinguished geoscientists: Professor Dr. Koshiro Kizaki of Japan and Mr. Madhav Raj Pandey of Nepal for their contribution to research and development of geoscience in the Himalayas. His Majesty also granted audience to the distinguished participant geoscientists from 32 countries.

The Symposium was attended by 419 geoscientists from 34 different countries. The participants were from the following countries and regions:

SAARC: Nepal (231), Bangladesh (4), India (18), Pakistan (2) and Sri Lanka (2).

Asia-Pacific region: Japan (56), China (7), Iran (3), Israel (4), Malaysia (2), Taiwan (1), Turkey (1), Australia (1) and New Zealand (1).

European countries: Austria (3), Czech Republic (1), Finland (3), France (17), Germany (6), Greece (4), Italy (27), Netherlands (1), Norway (1), Portugal (2), Romania (1), Slovenia (1), Sweden (3) and United Kingdom (5).

African continent: South Africa (1).

North America: United States of America (4) and Canada (2).

South America: Argentina (1), Brazil (2) and Colombia (1).

After the symposium, a one-day **excursion to Kathmandu-Kodari-Kathmandu** and a four-day **excursion to Kathmandu-Butwal-Pokhara-Kathmandu** were also organised. These excursions were attended by **30 and 90 participants**, respectively. The excursions were planned to show the participants various engineering geological problems along the mountain roads of Nepal, visits to hydropower projects, and the general geology of the Nepal Himalayas.

The Executive and Council meetings of the International Association for Engineering Geology and the Environment (IAEG) were also held in Kathmandu prior to the Symposium.

A total of **185 scientific research/working** papers including six keynote addresses were presented in the symposium.

Observing the IDNDR Day

Respected members, it is my great pleasure to inform that we completed the UN-declared International Decade (1990-2000) for Natural Disaster Reduction (IDNDR) Day by observing IDNDR-1999 Day with a one-day national meeting cum seminar on UN-declared theme "Prevention Pays" in the auditorium hall of the Russian Culture Centre on 12 October 1998. This programme was organised in close cooperation with HMG/Ministry of Home; IDNDR National Committee, Nepal; Water Induced Disaster Prevention Technical Centre (DPTC); UNDP, Nepal; Lutheran World Federation, Nepal; and National Society for earthquake Technology (NSET), Nepal. It was attended by more than 200 participants from various institutions and organisations. On this occasion, in addition to sharing of invaluable knowledge on natural disaster prevention with distinguished personalities, eight technical papers were also presented.

On the same occasion, Deputy Representative of UNDP/Nepal, Miss Saraswati Menon handed over the **1998 - UN Merituous Certificate for the Disaster Prevention** to the president of the Society. This award announced by the UN Humanitarian and Emergency Relief Co-ordination Office of IDNDR Secretariat in Geneva, Switzerland, was awarded to the Society for its efforts in disseminating the scientific knowledge and spreading the awareness of prevention of the natural disaster.

Decoration and Awards

On the auspicious occasion of 55th birthday, **His Majesty the King Birendra Bir Bikram Shah Dev** has decorated two of NGS members,

Mr. R. K. Aryal, President and Mr. K. P. Kaphle, Former President of Nepal Geological Society with **Prabala Gorakha Dakshin Bahu medal** for their devotion and efforts by organising International Symposium successfully through the Nepal Geological Society, in Nepal. Their contribution to uplift geoscience by publication of scientific journals, bulletins, and organising seminars, symposium, workshops and talk programmes on different occasions was recognised.

On the the same auspicious occasion, **HMG/ Ministry of Home decorated** Mr. Amod Mani Dixit, Coodinator of IDNDR Council of NGS, and Mr. U. B. Shrestha, Secretary, Nepal Geological Society with **Daivi Prakop Uddhar Padak.** It is to be recalled here that Mr. Ramesh Kumar Aryal was decorated with the same medal last year on the auspicious occasion of the 54th birthday of **His Majesty the King Birendra Bir Bikram Shah Dev.**

Participation of Nepal Geoecological Society at Various Meetings and Activities

Mr. R. K. Aryal, President, Nepal Geological Society on behalf of NGS took part in the two- day Workshop on "*Disaster Implementation Mannual Preparation*" at Nagarkot, on 29–30 October 1999.

Mr. R. K. Aryal, President and Mr. U. B. Shrestha, General Secretary, NGS, on behalf of NGS took part in the "*Role of Professional Societies in Promoting Science and Technology Capabilities*" at Hotel Archid, Tripureshor on 31 Ashadh 2056 B. S.

At the invitation of Mr. R. P. Tandukar, Project Chief, PEPP/ DMG and Mrs. Ellinor Melbye, Project Director, PETRAD, Mr. R. K. Aryal, President of NGS took part in the Inaugural Ceremony of the Workshop on *Negotiations of Petroleum Contracts* on 31 November 1999 at Hotel Himalaya, Lalitpur.

Mr. R. K. Aryal, President of NGS and Mr. K. P. Kaphle, Former president of NGS, took part in the Symposium on "*Experiences of Earthquake Risk Management*", organised jointly by NSET-Nepal, IOE, SCAEF, NEA and SONA on 15 January 2000. In this symposium, eleven papers were presented by national and foreign scientists.

Mr. R. K.Aryal, President, NGS, also took part in the *Second Earthquake Safety Day - 2000* and in the *Earthquake Safety Awareness Exhibition* organised by NSET-Nepal in Bhrikuti Mandap, Exhibition Hall Kathmandu on 14–16 January 2000.

Mr. R. K. Aryal, President, NGS, took part in the *National Science and Technology Congress* organised by the Ministry of Science and Technology in the Ministry of Science and Technology, Singha Durbar on 16 Marga 2056 B. S.

Mr. R. K. Aryal, President, NGS, attended the Inaugural Session of ***Teacher's Training Programme on Earth and Environmental Science*** organised by the Department of Geology, Tri-Chandra Multiple Campus, T. U. in collaboration with the Ministry of Education, HMG, Nepal and UNESCO on 10 March 2000.

Mr. R. K. Aryal, President, NGS, took part in the delegation lead by Dr. K. L. Shrestha, Advisor, Ministry of Science and Technology to meet Rt. Hon. Prime Minister, Mr. K. P. Bhattarai, in his office on 1st Chaitra, 2056 B. S. On this occasion Mr. Aryal briefed about the geoscientific activities carried out by the NGS in the past and also handed over a few volumes of the Bulletin and Journal of Nepal Geological Society to the Rt. Hon. Prime Minister.

Mr. R. K.Aryal, President, NGS, took part in the First Asia Meeeing of CIS Graduates and the 40th Anniversery of RPFO organised by Mitra Kunj, Nepal on 9th March 2000. It was inaugurated by Rt. Hon. Prime Minister Mr. K. P. Bhattarai.

Dr. B. N. Upreti, former president of NGS, participated in the 15th HKT Workshop held in China, between 15 and 22 April 2000.

Participation in the Exhibition

The Nepal Geological Society had actively participated in the Earthquake Safety Day 2000 programme (14–19 January 2000) organised by NSET and had installed an exhibition to uplift the prestige of the society.

Agreement

The Nepal Geological Society has signed an agreement with the Department of Mines and

Geology to sell the published geological maps of DMG from Paush 2056 onwards.

Journal Publication

Recently, the Society has published the Journal of NGS Vol. 19 and Abstract Volume of International Symposium on Engineering Geology, Hydrogeology and Natural Disasters with Emphasis on Asia, 28–30 September, 1999, Special Issue Vol. 20. Regular Vol. 21 is already sent for publication. Proceedings of the International Symposium on Engineering Geology, Hydrogeology, and Natural Disasters with Emphasis on Asia are at the final stage of editing and will be published by December 2000. This will be published as a Special Issue of the Nepal Geological Society, Vol. 22. There will be nearly 96 papers in this issue.

The regular News Bulletin of the Society, Vol.17 has already been published.

Members of the Society

The Society had gained considerable strength in its membership. At present, the Society has a total of 452 members and life members.

Respected members, now I would like to explain about forthcoming activities. On behalf of the Tenth Executive Committee, wherever we need your approval to conduct such activities I take my privilege to request for your guidance, suggestions, and lastly for the approval.

Observing ISDR-Day

The Executive Committee has decided to observe the UN declared ISDR-Day, (International Safety for Disaster Reduction Decade). The necessary correspondence to observe this day is in the process with the Ministry of Home.

Honorary Membership of the Society

As per the Constitution of the Nepal Geological Society 2037, Article No. 9, the Tenth Executive Committee of the Society had decided to provide the Honorary Membership to two of its distinguished members for their remarkable contribution towards the development of geoscience in the Himalayas. For this the Tenth Executive Committee had formed the Honorary Membership Selection Committee. The Committee recommended the names of two distinguished geoscientists to the tenth post due executive committee.

On 2057/5/12, the Honorary Membership Selection Committee had unanimously recommended the Tenth Executive Committee to provide the Society's Honorary membership to:

- Professor Dr. K. S. Valdiya (LM292 from India) and
- Dr. Patrick Le Fort (LM92 from France).

I would like to request your approval for providing the distinguished personalities with our Society's Honorary Membership.

Third Nepal Geological Congress

The Tenth Executive Committee had previously decided to organise the Third Nepal Geological Congress in October–November 2002. But in the same year in April, 17th HKT Workshop is going to be held in Delhi, India. Hence, we are afraid that if we organise the Third Nepal Geological congress in 2002, the participation of the geoscientists from this region and other parts of the world not be as expected. And, if we have to organise the Congress in 2001, we are in shortage of time and will have a very difficult situation to obtain the financial assistance. Therefore, the Tenth Executive Committee had decided to obtain the suggestion and recommendations from the General Body. Hence, I would like to request the respected members of the Society for providing their suggestions and final approval of the time for organising the Third Nepal Geological Congress.

Resignation of the Member of the Executive Committee

The resignation of Mrs. Shobha Singh from the Tenth Executive Committee due to her long-term training in Europe was accepted by the Tenth Executive Committee. As she is one of the elected members of the Executive Committee, the vacant post due to her resignation was decided to fill up in accordance with the recommendation from the General Body. Hence, I request that the

vacant position be filled up from this General Body meeting of the Society.

Formation of the Stratigraphic Commission of Nepal Geological Society

The Tenth Executive Committee had a overwhelming pressure from the members of the Society to form a Stratigrapic Commission of Nepal Geological Society. The Tenth Executive Committee had decided to take action in this regard after the recommendation from the General Body of the Society. Therefore, I would like to open the floor for discussion.

Organising a National-level Seminar

Once the date for the Third Nepal Geological Congress is fixed upon the recommendation from the General Body meeting of the Society, if the Congress is not to be organised within 2001, the Tenth Executive Committee has decided to organise a national-level seminar in 2001.

Dear members, whatever we are able to do during the year are due to your help, support, and advice. On behalf of the Executive Committee and myself, I would like to offer our sincere thanks to all of you for your active cooperation and continued support all the time. Various governmental and non-governmental organisations and agencies, have provided technical and financial support to the Society. The Tenth Executive Committee would like to thank those organisations and agencies and hopes that such cooperation will be continued in the future. Particularly, I would like to mention here the following organisations:

- Department of Mines and Geology;
- Petroleum Exploration Promotion Project;
- Groundwater Resources Development Project;
- Department of Irrigation;
- Central Department of Geology, Kirtipur Campus, Tribhuvan University;
- Department of Geology, Tri-Chandra Campus, Tribhuvan University;
- DPTC;
- UNDP/Nepal;
- Lutheran World Service;
- BGR/DMG;
- Nepal Electricity Authority;
- Nepal Electricity Development Centre;
- Ministry of Home;
- ICIMOD;
- Ministry of Science and Technology;
- Nepal Engineers' Association;
- UNESCO, Delhi;
- IUGS;
- IAEG; and
- NSET.

While working, there may have been shortcomings and weaknesses from our part. For this, I would like to take this opportunity to extend our sincere apology on behalf of the Executive Committee. Also, at this moment, we would like to renew our request once again for the continuation of your support, advice, and cooperation as well as to point out our weaknesses. We sincerely hope that we will be guided by the respected members of the Society in the future.

Thank you.

Respected Members, now I would like to open the floor for discussion, suggestions, guidance, and finally approval of our proposals.

The Tenth Executive Committee had recommended to form a Stratigraphic Commission of Nepal Geological Society. The Tenth Executive Committee would like to get the recommendation from this General Body meeting.

Once the date for the Third Nepal Geological Congress is fixed upon the recommendation of the General Body meeting, if the Congress is not to be organised within 2001, the Tenth Executive Committee has decided to organise a national-level seminar in 2001.

Financial Report of FY 2056/057 by Mr. Arjun Aryal, Treasurer, NGS

श्रीमान सभापति महोदय,
सम्मानित सदस्यज्यूहरु,
भूतपूर्व अध्यक्षज्यूहरु,
समाजका आदरणीय सदस्यज्यूहरु,

सर्वप्रथम यस २१ औं साधारण सभामा नै. भौ. स. को कोषाध्यक्षको हैसियतले यस समाजको आर्थिक प्रतिवेदन पेश गर्ने मौका प्रदान गर्नु भएकोमा महोदयलाई हार्दिक धन्यवाद दिन चाहन्छु। आर्थिक वर्ष २०५५/२०५६ को आर्थिक विवरण गत वर्ष नै प्रस्तुत भैसकेको कुरा महोदयलाई अवगतै छ र आज म आर्थिक वर्ष २०५६/२०५७ को आर्थिक विवरण पेश गर्न गईरहेको छु।

आदरणीय सदस्यज्यूहरु,

यस समाजको आर्थिक कारोबार बढ्दै गएको अवस्था र हामी जस्तो भिन्दै पेशाका व्यक्तिलाई ठूलै आर्थिक कारोबार गर्न र त्यसलाई नियमित रुपमा आर्थिक ढाँचामा राख्न निकै कठिन हुँदै गएको कुरा विगतका वर्षहरूमा पनि भएकै हो। यो समस्या गत वर्ष सम्पन्न International Symposium को ठूलो कारोबारले गर्दा झनै जटिल भएता पनि यस का. का. स. का पदाधिकारीज्यूहरु, Symposium Organising Committee तथा समाजका अन्य Sub-Committee का Chairman तथा सदस्यज्यूहरु र समाजका अन्य सदस्यज्यूहरु एवं अन्य महानुभावहरूको महत्वपूर्ण सहयोगले गर्दा यो कार्य सम्पन्न भएको कुरा अवगत गराउँदै आर्थिक गतिविधिमा सहयोग गर्नु हुने सम्पूर्ण महानुभावहरुलाई धन्यवाद दिन चाहन्छु।

हाल समाजको गत वर्ष भएको सम्पूर्ण आर्थिक कारोबारलाई एक अधिकार-सम्पन्न लेखा परीक्षकबाट परीक्षण समेत गराई उक्त आर्थिक विवरण तयार भइसकेको छ। यस गतिविधिमा समाजको आर्थिक कारोबार स्पष्ट र पारदर्शी रहोस् र समाजको आर्थिक लाभ वृद्धि हुँदैजाओस् भन्ने उद्देश्यले मेरो क्षमताले भ्याएसम्म काम गर्दा गर्दै पनि कुनै त्रुटि भएकोछ भने सदस्यज्यूहरूमा क्षमा प्रार्थी छु।

आदरणीय सदस्यज्यूहरु,

यस समाजको गत वर्षको Income and Expenditure र Receipt and Payment सम्बन्धी विवरणहरु महोदयलाई प्राप्त भइसकेकाले उक्त विवरणका केही झलक पेश गर्ने अनुमति चाहन्छु।

यस समाजको गत वर्षको जम्मा आम्दानी Rs. 39,18,218.04 भएको र खर्च Rs. 29,53,066.07 भएकोले बचत Rs. 9,65,151.97 हुन गएको छ। यस समाजसँग हाल जम्मा Rs. 30,76,222.68 मौज्दात रहेको कुरा अवगत गराउँदछु।

गत आर्थिक वर्षमा भएको प्रमुख आम्दानी र खर्चहरु खास गरी International Symposium सँग सम्बन्धित छन्। यस वर्षको आम्दानी यस प्रकार छ।

Membership fees	NRs.25,600.00
Journal sales and subscription	NRs.71,845.00
Registration and excursion costs	NRs.26,235.80
Contribution	NRs.9,61,840.00
Advertisement	NRs.72,000.00

गत आ. व. मा International Symposium संचालन एवं Printing का लागि प्राप्त भएको सहयोग निम्न बमोजिम छ।

IAEG	US$ 3,000.00
UNESCO	US$ 2,500.00
DASE France	US$ 600.00
AGID	US$ 120.00
Nepal Electricity Authority	NRs. 1,000,00.00
Impregelo Kalinganaki	NRs. 50,00.00
MKI	NRs. 30,000.00
Silt Consult (P) Ltd.	NRs. 35,000.00
Lutheran World Federation Nepal	NRs. 25,000.00
Shah Consult P. Ltd.	NRs. 25,000.00
ITECO Nepal and Cement	NRs. 20,000.00
Sub Structural Consult	NRs. 15,000.00
GEOCE Consult (P) Ltd.	NRs. 15,000.00
Soil Test P. Ltd	NRs. 12,500.00
NADCO P. Ltd.	NRs. 12,500.00
TAEC Consult	NRs. 10,000.00
N-SET Nepal	NRs. 10,000.00
Continental Trading (P). Ltd.	NRs. 10,000.00
East Consult (P) Ltd.	NRs. 10,000.00
Butwal Power Company (BPC)	NRs. 5,000.00
Dip Consultancy	NRs. 3000.00

त्यसैगरी, IDNDR Day मनाउनका लागि UNDP बाट NRs. 60,000.00 गृह मन्त्रालयबाट Rs. 10,000.00 र Lutheran World Federation बाट Rs. 10,000.00 प्राप्त भएको थियो ।

अधिल्ला आ. व. सहित सारांशमा International Symposium को बेला को आम्दानी र खर्च निम्न बमोजिम छ ।

आम्दानीहरु

Registration	NRs. 22,21, 060.00
Excursion	NRs. 12,62,920.00
Advertisement	NRs. 72,000.00
Contribution and Symposium	NRs. 15,61,840.00
Miscellaneous	NRs. 72,360.00
Total	**NRs. 51,90,180.00**

Symposium को खर्चमा यस आ. व. मा. करिब NRs. 28,50,000.00 र अधिल्लो आ. व. मा करिब NRs. 3,00,000.00 गरी जम्मा करिब NRs. 31,50,000.00 भयो ।

यसरी Symposium बाट मात्र करिब २१ लाख जति प्रत्यक्ष आम्दानी भएको छ ।

तर यस आम्दानी मध्ये केही रकम Symposium को Proceeding Printing र Postage मा खर्च हुनसक्ने कुरा पनि अवगत गराउँदछु ।

यस आ. व. मा समाजले किनेका जिन्सी सामानहरुमा 100 MB को एक ZIP Drive र ३ वटा काठका दराज र २ वटा Display Board गरी हाल समाजसँग निम्न सामानहरु छन् ।

क. स.	विवरण	संख्या
१.	Steel दराज २ वटा Geology Department of Tri-Chandra Campus मा Treasurer संग १ २ वटा DMG Society को Office मा	४
२.	काठको दराज - DMG Society को Office मा	२
३	Computer Pentium–I (R.K. Aryal संग भएको ।	१
४.	HP LaserJet Printer 6L (Chief Editor M. R. Dhital संग।	१
५.	External Zip Drive 100 MB (Chief Editor M. R. Dhital संग।	१
६.	Display Board (DMG Society Office मा)	२
७	Journal and Bulletin हरू (हाल थान गन्ति नभएको)	

अब म यो आ. व. २०५६/२०५७ को आर्थिक विवरण प्रतिकृयार्थ यहाँहरू समक्ष पेश गर्दछु ।

धन्यवाद ।

Auditor's Financial Report of Fiscal Year 2056/057

The Members
Nepal Geological Society
Kathmandu

Gentlemen,
I have audited the attached Receipt and Payment Account for the year ended on 32nd Shrawan 2057, and reports as follows:

1. I have got all the information and explanations which are required for the purpose of audit.
2. Proper books as required are maintained according to Company's Law.
3. The attached Receipt and Payment Account and Income and Expenditure Account are drawn properly up in accordance with records which are made available to me.
4. According to the information given to me the attached Income and Expenditure Accounts prepared for the year ended 32nd Shrawan 2056 exhibit true and fair view.

Sd.
(Babu Raja Bajracharya)
Registered Auditor

Date: 10th Bhadra 2057

Nepal Geological Society

RECEIPT & PAYMENT ACCOUNT

For the year ended 32 nd Shrawan 2057

Receipt	Amount (Rs.)	Payment	Amount (Rs.)
To Cash	12,551.00	By Advance A/C	5,000.00
To Bank	2,085,008.71	By Advertisement	5,005.00
To Advertisement	72,000.00	By Audit Fee	4,000.00
To Associate Membership Fee	900.00	By Bank Commission $382.61	27,547.92
To Excursion	29,920.00	By Bank Commission	350.00
To Excursion $11925	858,600.00	By Catering Service	33,893.00
To Membership Fee	2,500.00	By Deposit	2,000.00
To Interest Received	46,070.43	By Equipment	10,300.00
To Interest Received $749.78	53,984.16	By Excursion	634,752.00
To Journal Sale	11,077.00	By Fuel and Transportaion	36,988.00
To Journal Sale $644	46,368.00	By Furniture	23,000.00
To Journal Subscription $200	14,400.00	By Hotel Bills	820,499.00
To Life Membership Fee	7,800.00	By Map Purchase	14,200.00
To Life Membership Fee $200	14,400.00	By Miscellaneous Expenses	89,915.00
To Map Sale	4,000.00	By Photocopy	36,832.50
To Miscellaneous Income	59298.45	By Postage and Communication	39,284.30
To Registration	512,500.00	By Refreshment	58,145.50
To Registration $ 16980	1,222,560.00	By Rent	440,650.00
To Sponsorship and Cont.	514,000.00	By Salary & Remuneration	53,264.00
To Sponsorship and Cont. $6220	447,840.00	By Seminar Bags & T-shirts	241,860.00
		By Stationery	96,468.50
		By Printing	259,950.00
		By Tax on interest	242.07
		By Tax on interest $	3,239.28
		By Travel Grants	15,680.00
		By Agri. Dev. Bank Fixed	315,400.00
		By Agri. Dev. Bank Saving	61,259.15
		By Nabil Bank Dollar A/C $29719.14	2,139,778.06
		By Nabil Bank Fixed	29,000.00
		By Nabil Bank Saving	450,436.47
		By Nepal Bank Ltd. Bhotahity	6,364.23
		By Nepal Bank Ltd. Current	9,949.27
		By Nepal Bank Ltd. Fixed	37,000.00
		By Cash in Hand	13,524.50
Total	**6,015,777.75**	**Total**	**6,015,777.75**

(US$ 1 = NRs. 72.00)

Treasurer
Arjun Aryal

General Secretary
Uttam Bol Shrestha

President
Ramesh K Aryal

Auditor
Baburaja Bajracharya

Nepal Geological Society

INCOME & EXPENDITURE ACCOUNT

For the year ended 32 nd Shrawan 2057

Expenditure	*Amount (Rs.)*	*Income*	*Amount (Rs.)*
To Advance	5,000.00	By Advertisement	72,000.00
To Advertisement	5,005.00	By Associate Membership Fee	900.00
To Audit Fee	4,000.00	By Excursion	29,920.00
To Bank Commission	350.00	By Excurtion $ 11925	858,600.00
To Bank Commission $382.61	27,547.92	By Interest Received	46,070.43
To Catering Services	33,893.00	By Interest Received $749.78	53,984.16
To Deposit	2,000.00	By Journal Sale	11,077.00
To Equipment	10,300.00	By Journal Sale $644	46,368.00
To Excursion	634,752.00	By Journal Subscription $200	14,400.00
To Fuel and Transportation	36,988.00	By Life Membership Fee	7,800.00
To Furniture	23,000.00	By Life Membership Fee $200	14,400.00
To Hotel Bills	820,499.00	By Map Sale	4,000.00
To Map Purchase	14,200.00	By Membership Fee	2,500.00
To Miscellaneous Expenses	89,915.00	By Miscellaneous Income	59298.45
To Photocopy	36,832.50	By Registration	512,500.00
To Postage and Communication	39,284.30	By Registration $ 16960	1,222,560.00
To Printing	259,950.00	By Sponsorship and Contribution	514,000.00
To Refreshment	58,145.50	By Sponsorship and Contribution $6220	447,840.00
To Rent	440,650.00		
To Salary &Remuneration	53,264.00		
To Seminar Bags and T-shirts	241,860.00		
To Stationery	96,468.50		
To Tax on Interest	242.07		
To Tax on Interest	3,239.28		
To Travel Grants	15,680.00		
To Surplus (income over expenditure)	965,151.97		
Total	**3,918,218.04**	**Total**	**3,918,218.04**

(US$ 1 = NRs. 72.00)

Treasurer
Arjun Aryal

General Secretary
Uttam Bol Shrestha

President
Ramesh K Aryal

Auditor
Baburaja Bajracharya

एक्काइसौं वार्षिक साधारण सभामा भएका छलफल तथा निर्णयहरु

भू-विज्ञानमा र खास गरेर नेपाल हिमालयमा भौगर्भिक अनुसन्धानात्मक कार्यहरु गरी विशेष योगदान पुऱ्याएको आधारमा अघज दुईजना भू-वैज्ञानिकहरुलाई सम्मान गरी सम्मानित सदस्य (Honorary Member) प्रदान गर्ने परिपाटी यस ने. भौ. स. ले गर्दै आएकोमा यो वर्ष पनि सोको लागि उपयुक्त व्यक्तिहरु छनौट गरी उहाँहरुको नाम सिफारिश गरी का. का. स. मा पठाउन गठित उपसमितिले भारतका भूगर्भविद् Professor Dr. K. S. Valdiya र France का भूगर्भविद् Dr. Patrick Le Fort को नाम सिफारिश गरी का. का. स. ले उक्त नामहरु साधारण सभाबाट अनुमोदन (पास) गराउनका लागि पेश हुँदा साधारण सभामा सर्वसम्मतिबाट उहाँहरुलाई सम्मानित सदस्य प्रदान गर्ने निर्णय भयो ।

यस समाजका आजीवन सदस्य एवम् Chief Editor डा. मेघराज पितालले Stratigraphic commission / Council स्थापना गर्न आवश्यक भएकोले सो को स्थापनाका लागि Proposal राख्दै भन्नु भयो– कुनै पनि क्षेत्रको भौगर्भिक अध्ययनमा भौगर्भिक Unit को नामाकरण गर्दा Standard Stratigraphy अनुसार नामाङ्कन हुनु अति आवश्यक छ। त्यसैले नामाकरणको स्तरीयता कायम गर्न एउटा निकाय हुनु जरुरी छ । हाल Nepal Geological Society का साथै Stratigraphic Society समेत भएको कुरालाई मध्येनजर राखी यसबारे चर्चागर्नु आवश्यक छ। अहिलेसम्म हामा Standard Stratigraphic Unit हरु नभएको हुँदा Map Publication मा कठिनाई परेको छ ।

यसैगरी ने. भौ. स. का पूर्व अध्यक्ष एवम् आजीवन सदस्य कृष्ण प्रसाद काफ्लेले भन्नुभयो- यो विषय अत्यन्त महत्वपूर्ण भएकोले यसमा सम्पूर्ण सदस्यहरुले गहन विचार गरी भौगर्भिक अध्ययनमा Standard Stratigraphic Unit अनुसार नै भौगर्भिक Unit हरूको नामाकरण गर्ने गरी भौगर्भिक नक्साहरू बनाउन अति जरुरी छ । यसरी हामीले पहिले गरेका गल्तीहरूलाई सुधार गर्दै नक्साहरु Standardise गर्नु पर्छ । यसको लागि NGS, DMG, T. U. लाई समेटेर एउटा Authorised Body बनाउनु पर्दछ ।

यसै गरी भौगर्भिक समाजका आजीवन सदस्य एवम् पूर्व अध्यक्ष डा. विशालनाथ उप्रेतीले यो विषयमा एउटा समिति नै बनाई त्यसलाई काम सुम्पिनु पर्छ का. का. स. ले यो Commission बनाउनु पर्ने भनुभयो ।

छलफलकै क्रममा, समाजका अर्को आजीवन सदस्य डा. राम बहादुर साहले हाल T. U. मा रहेको Stratigraphic Society ले पनि यस विषयमा ने. भौ. स. ले बनाउने Stratigraphic Commission लाई सहयोग गर्न तयार छ भन्नु भयो ।

यसपछि समाजका आजीवन सदस्य एवम् पूर्व अध्यक्ष डा. रमेश प्रसाद वस्यालले Stratigraphic Council लाई ने. भौ. स. ले पूर्ण सहयोग गर्नुपर्छ र उक्त काम सम्पन्न गर्न र उक्त Commission लाई परिआउने खर्चको लागि Funding को पनि व्यवस्था गर्नु जरुरी छ भन्नुभयो ।

ने. भौ. स. का आजीवन सदस्य एवं पूर्व अध्यक्ष अच्युतानन्द भण्डारीले ने भौ. स. अन्तर्गत एउटा Commission नै खडा गर्नु पर्छ जसले Stratigraphic Unit हरू कायम गर्न सकोस् । त्यसैले का. का. स. ले यस विषयमा तुरुन्त काम थालोस् र अर्को २२ सौं साधारण सभामा Commission को बारेमा प्रस्तुत होस् भन्नुभयो ।

यस क्रममा यस समाजका आजीवन सदस्य एवं पूर्व अध्यक्ष आमोद मणि दीक्षितले उक्त प्रस्तावित Commission को Autonomous Body हुनुपर्छ भन्नुभयो । यसरी भएको छलफल पश्चात Stratigraphic Commission of Nepal नामाकरण गर्ने र सो Commission को गठन गर्ने का. का. स. लाई पूर्ण अधिकार दिने सर्वसम्मतिबाट निर्णय भयो ।

यसपछि नेपाल भौगर्भिक समाजले आउँदो सेप्टेम्बर मा 3rd Nepal Geological Congress को काठमाडौंमा आयोजना गर्ने कि भन्ने बारे छलफल हुँदा सर्वसम्मतिबाट उक्त Geological Congress सेप्टेम्बर २००९ मा आयोजना गर्ने कुरा सर्वसम्मतिबाट निर्णय भयो ।

यसरी छलफलको कार्यक्रमलाई अघि बढाउने सिलसिलामा का. का. स. का सदस्य श्रीमती शोभा सिंह विदेश अध्ययन गर्न गएको हुँदा रिक्त हुन आएको सदस्य पदमा पद परिपूर्ति गर्ने छलफल हुँदा समाजका आजीवन सदस्य डा. इन्द्र राज हुमागाईं र डा. दमयन्ती गुरुङको नाम प्रस्तुत हुँदा डा. गुरुङले असमर्थता देखाएकोले यस समाजका डा. हुमागाईंलाई सर्वसम्मतिबाट का. का. स. को सदस्यमा मनोनित गरियो र तत्कालै समाजका अध्यक्ष रमेश कुमार अर्यालले उहाँलाई सदस्यताको सपथ ग्रहण गराउनु भयो ।

यसपछि विविध छलफलको क्रममा यस समाजका आजीवन सदस्य आमोद मणि दीक्षित नेपालका युवा भूगर्भविद्हरूको लागि प्रोत्साहान स्वरुप ने. भौ. स. ले केही पुरस्कार राख्नु पर्छ भन्ने प्रस्ताव राख्नुभयो ।

यस समाजका अर्का आजीवन सदस्य डा. मेघ राज धितालले हाम्रो नेपाल भौगर्भिक समाजले कुन कुन क्षेत्रमा कुन कुन कार्यालय, विभागहरुमा भूगर्भविद्को आवश्यकता छ भन्ने कुरा बुझी पदस्थापना वा पदपूर्तिकालागि विशेष पहल गर्न आवश्यक छ यसको लागि नेपाल भौगर्भिक समाजले छुट्टै कमिटी गठन गरी आवश्यक काम थालनी गरिनु पर्छ भन्नुभयो । का. का. स. ले गठन गरेमा विभिन्न कार्यलयहरुमा जान तयार छौं भन्नुभयो ।

यसरी नै अर्का आजीवन सदस्य छत्राज देव भट्टराईले ने. भौ. स. ले हाम्रा नयाँ भूगर्भविद्हरुका लागि सरकारी एवं गैरसरकारी संस्थाहरुमा भूगर्भ विज्ञानको आवश्यकता र भूगर्भविद्हरुको औचित्य बारे अवगत गराई थप नयाँ नयाँ कामहरु गर्न लगाई भूगर्भविद्हरुलाई Job create गराउनमा पहल गर्नुपर्ने कुरा व्यक्त गर्नुभयो ।

छलफलकै क्रममा यस समाजका अर्का आजीवन सदस्य तथा पूर्व अध्यक्ष आमोद मणि दीक्षिले यस सम्बन्धमा ने. भौ. स. ले एउटा बेग्लै Commitee गठन गर्ने र सो कमिटीले उक्त विषयमा काम थाल्नु पर्ने कुरा व्यक्त गर्नुभयो ।

यस समाजका अध्यक्ष अर्यालले गत वर्ष हामीले प्र. म. श्री कृष्ण प्र. भट्टराईलाई भेटेका बेला यस सम्बन्धमा हाम्रो कुरा राखेको र NGS का कार्यक्रमहरु ज्ञात गराउनुका साथै Journal, Bulletin पनि दिएको बताउनु भयो ।

यसमा भएको छलफल पश्चात् डा. मेघराज धितालको संयोजकत्वमा एउटा कमिटी गठन गर्ने निर्णय भयो । उक्त कमिटीले भूगर्भविद्हरुको कार्यक्षेत्र विस्तार गर्ने विषयमा काम गर्नेछ ।

यसै क्रममा पूर्व अध्यक्ष डा. विशालनाथ उप्रेतीले २ वर्ष पूर्व सडक विभाग र Dept. of Soil Conservation मा समाजका प्रतिनिधिहरु गएर उक्त कार्यालयहरुमा भूगर्भविद्हरुलाई स्थान सुरक्षित गराउन पहल गरिएको थियो । तर हालसम्म उक्त विभागहरुमा स्थायी भूगर्भविद्हरुको दरबन्दी कायम गरिएको छैन भन्नुभयो ।

छलफलका क्रममा केही सदस्यहरुले खा. त. भू. वि. मा नयाँ सङ्गठन तालिका अनुसार केही भूगर्भविद्हरुको दरबन्दी काटिएको छ कि ? भन्ने प्रश्नमा आजीवन सदस्य जगदीश्वर नाथ श्रेष्ठले भूगर्भविद्हरुको दरबन्दी नकाटिएको कुरा प्रष्ट पार्नुभयो ।

यसै क्रममा आजीवन सदस्य डा. पीताम्बर गौतमले हाल विभिन्न विभाग, संस्था, कलेज एवं युनिभर्सिटीहरुमा कार्यरत वरिष्ठ भूगर्भविद्हरुलाई बोलाएर यस विषयमा छलफल गरी अन्य कुन कुन विभाग तथा कार्यालयहरुका भूगर्भविद्हरुको आवश्यकता हुन सक्छ सो पत्ता लगाई उक्त कार्यालयहरुमा approach गर्न रामो हुने कुरा व्यक्त गर्नु भयो ।

यसै प्रसङ्गमा पूर्व अध्यक्ष आमोद मणि दीक्षितले यस बारेमा तुरुन्त एक मिटिङ्ग गराई एक टोली गठन गरी विभिन्न ठाउँमा approach गर्न रामो हुने कुरा व्यक्त गर्नु भयो । यस पछि सदस्य श्रीकमल द्विवेदीले जलश्रोत मन्त्रालयमा हाल एक भूगर्भविद्को दरबन्दी खाली भएको जानकारी दिनुभयो ।

छलफललाई अगाडि बढाउने क्रममा समाजका आजीवन सदस्य महेश नकर्मीले विभिन्न जिल्लाहरुका कृषि सडक बन्ने कार्य भइरहेको तर त्यस्ता कार्यमा भूगर्भविद्हरुलाई समावेश नगराइएको हुँदा सडक जथाभावी खनिएको पाइएको छ । त्यस्तै कृषि सडक बनाउँदा भूगर्भविद्हरुको सल्लाह हुनु अत्यावश्यक भएको हुँदा त्यस्ता योजनाहरुमा भूगर्भविद्हरुको स्थान सुरक्षित गराउनेतर्फ कदम चाल्नुपर्यो ।

छलफलकै क्रममा अर्का आजीवन सदस्य अच्युतानन्द भण्डारीले ने. भौ. स. ले देशमा विभिन्न समयमा हुने प्राकृतिक प्रकोपबाट हुने र भएका क्षतिहरुबारे समयमै अध्ययन गराउने गरेको तर यसपटक पृथ्वी राजमार्गको कृष्ण भिरमा गएको पैरोको अध्ययन गर्न नेपाल भौगर्भिक समाजले किन टिम पठाएन यस सम्बन्धमा जानकारी गराउनुपर्यो भन्नुभयो ।

यस पछि समाजका आजीवन सदस्य तथा प्रमुख सम्पादक डा. मेघ राज धितालले NGS को Journal Vol. 21 Press मा गई सकेको र केही दिन भित्रै निस्कनेछ । "International Symposium on Engineering Geology, Hydrogeology, and Natural Disasters with Emphasis on Asia" को Proceedings (NGS को Journal Vol. 22) को Editing कार्य शुरु भैसकेको छ र यही December भित्रै प्रकाशनमा ल्याउने लक्ष्य छ । उक्त Proceeding Standard Size मा छाप्ने प्रयास गरिने छ भन्नुभयो । उक्त समयमा डा. धितालले Proceedings तयार गर्दा पर्ने आउने कठिनाई बारेमा पनि प्रकाश पार्नु भएको थियो ।

यसै क्रममा आजीवन सदस्य अनन्त गजुरेलले Editing को कार्य निकै समय लाग्ने र कठिन भएको हुँदा यसमा सहयोग गर्ने साथीहरु स्वयम् अगाडि आउनुपर्यो भन्नुभयो र साथै technical editing committee खडा गर्नुपर्यो नत्र भने paid basis मा editing कार्य गराउँदा निकै महँगो हुने कुरा पनि स्पष्ट पार्नुभयो ।

यस पछि अर्का आजीवन सदस्य रन्जन कुमार दाहालले ने. भौ. स. को आफ्नो घर हुनु पर्यो र सो नभए कमसेकम

२-३ कोठा सहितको अफिस हुनु आवश्यक छ भन्ने जिज्ञासामा समाजका अध्यक्ष रमेश कुमार अर्यालले हाल पस समाजसँग जग्गा खरिद गरी घर बनाउने आर्थिक क्षमता नभएको तर अफिसको सचालनको लागि खा. त. मु. वि. ले कोठा र अन्य कतिपय सुविधाहरु उपलब्ध गराएको हुंदा अफिस संचालनमा त्यति कठिनाई नभएको कुरा बताउनु भयो।

अन्त्यमा कोषाध्यक्षले प्रस्तुत गर्नुभएको आर्थिक प्रतिवेदनमा Expenditure मा विदेशी रकम मध्यको हिसाबमा Convert गर्दा किन धेरै फरक भएको हो भन्ने सदस्य जगदीश्वरनाथ श्रेष्ठको प्रश्नको जवाफमा कोषाध्यक्ष श्री अर्जुन अर्यालले Exchange rate समय समयमा फरक हुने हुंदा त्यस्तो देखिएको हो भनि स्पष्ट पार्नु भयो।

छलफलको कार्यक्रम समाप्त भए पछि अन्त्यमा समाजका उपाध्यक्ष श्री वासुदेव खरेलले नेपाल भौगर्भिक समाजको कार्यकारिणी समितिका तर्फबाट धन्यवाद ज्ञापन गर्नुभएको थियो।

ARTICLES

Earthquake and Earthquake Hazards in Nepal

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INTRODUCTION

Earthquakes are the most sudden, dramatic, and devastating natural disasters. They only last for seconds to minutes, but are the most frightening and devastating. In case of a great earthquake, the devastation is widespread and can completely paralise a country or a region for days to months. Furthermore, it may take many years to recover from the damage to the infrastructure and the economy of a country. The trauma and sufferings of survivors may last for a lifetime. In general, the Asian countries such as, Iran, Afghanistan, China, Pakistan, India, Nepal, Bhutan, Bangladesh, Burma, Indonesia, Philippines, and Japan lie in zones of very high seismic risk.

The most recent devastating earthquakes in India (Gujarat, Magnitude 7.9, January 26, 2001, Chamoli, Magnitude 6.8, March, 29, 1999); Taiwan (Chi-Chi, Magnitude 7.8, Sept. 9, 1999); Turkey (Izmit, Magnitude. 7.4, August 17, 1999; and Duzce, Magnitude. 7.1, November 12, 1999); Greece (Athens, Magnitude 5.9, Sept, 1999); and Japan (Kobe, Magnitude. 7.2, January 17, 1995) indicate how vulnerable we are to earthquakes. All these disasters have amply warned us to be better prepared for the future.

Earthquakes cannot be prevented and we are far from being realistically able to predict them. Therefore, we must learn to live with them and at the same time be prepared in advance towards mitigating earthquake hazards by utilising all the tools that are available from the recent advances in science and lessons learnt from previous events.

WHAT IS AN EARTHQUAKE?

The earth is a dynamic body and is constantly changing, moving, and is full of energy. This dynamism comes from the internal heat energy of the earth. The earth's uppermost layer (about 100 km thick) is called **lithosphere** (Fig. 1). The lithosphere is broken into many pieces called plates (Fig. 2). These plates are constantly moving in different directions like floating bodies of iceberg on an ocean. At the boundary of the plates the rocks are continuously undergoing deformation (change in shape and/or volume) which is due to forces exerted by the moving plates. During the process of deformation of a plate, a great amount of energy is gradually accumulated and stored. The stored energy is ultimately released when the rock body no longer can hold that energy. This energy is instantly released when the deforming rock ultimately breaks along a fracture and the two parts move apart (Fig. 3 and 4). The smooth fracture along which two blocks of the rock move with respect to each other is called a **fault**.

When an accumulated energy is suddenly released, it travels through the earth and produces **waves in the rock (called seismic waves)** causing the earth's crust to shake for a period of time. This is similar to the phenomenon when a stone is thrown into a pool. The dropping of a stone creates a series of waves like seismic waves that spread through the water in all directions.

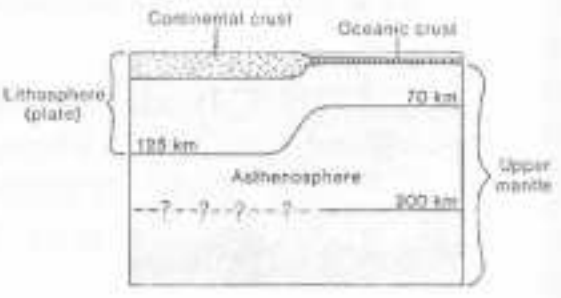

Fig. 1: Structure of the lithosphere

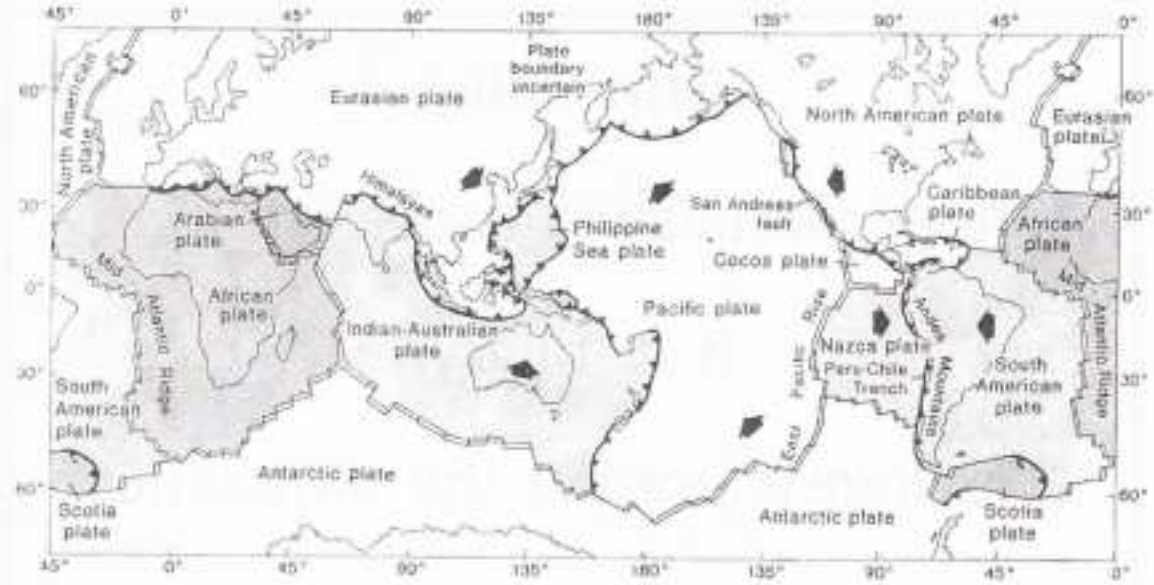

Fig. 2: Major plates and their boundaries

(A) Rocks remain undeformed in seismically inactive areas.

(B) Strain builds up in rocks in seismically active areas until the rocks rupture or move along preexisting fractures.

(C) Energy is released when the rocks rupture and seismic waves move out from the point of rupture.

Fig. 3: Diagram showing the development of a fault and an earthquake

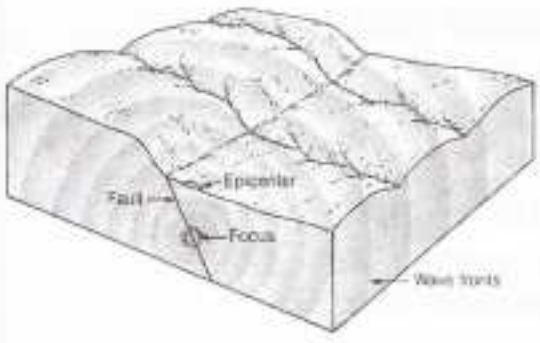

Fig. 4: Epicentre and focus of an earthquake

The accumulated energy starts to be released from a point within the earth, which is called **focus**. The point on the earth's surface vertically above the focus is called **epicentre** (Fig. 3). Once a fault is formed, it becomes a periodic source of earthquakes as long as the forces continue to act upon the body and deform it as before. The earthquakes caused by the sudden earth movements along a fault is known as **tectonic earthquakes.** The vast majority of earthquakes, including all the most disastrous examples, are caused by the movement of rocks along a fault.

EARTHQUAKE STRENGTH

Intensity

The strength of earthquakes is measured in two ways. One method is to find out how much and what kind of damage the quake has caused. This determines the **intensity**, which is a measure of an earthquake's effect on people and buildings. Intensities are expressed as Roman numerals ranging from I to XII on the Modified Mercalli scale. Higher number indicates greater damage. No instruments are required to measure intensity. It is determined by visual inspection of damage after an earthquake. The measure of peak Intensity of earthquake (in the epicentral area) and corresponding magnitude is given in Table 1.

Magnitude

The second method of measuring the strength of a quake is to calculate the amount of energy released at the earthquake's focus. Interpretation of seismograms (the instrumental record of earthquake) has made possible to calculate the quantities of energy released by earthquakes of various magnitudes. In 1935, a leading seismologist Charles F. Richter brought forth a scale of earthquake magnitudes describing the quantity of energy released at the earthquake focus. This scale consists of numbers ranging from 0 to 8.6.

The **magnitude** of an earthquake is a measure of the amount of energy released. Magnitudes are

Table 1: Scale of earthquake intensity (Modified Mercalli Intensity Scale)

Scale	Description of characteristic effects	Magnitude (Richter Scale) corresponding to highest intensity reached
I	**Instrumental**: Not felt except by very few people under special conditions. Detected mostly by instruments	3.5-4.2
II	**Feeble**: Felt by a few people, especially those on upper floors of buildings. Suspended objects may swing.	
III	**Slight**: Felt noticeably indoors. Standing automobiles may rock slightly. Vibrations like passing of truck.	
IV	**Moderate**: Felt by many people indoors, by a few outdoors. At night, some are awakened. Dishes, windows, and doors rattle.	4.3-4.8
V	**Rather Strong:** Felt by nearly everyone. Many are awakened. Some dishes and windows are broken. Unstable objects are overturned.	
VI	**Strong**: Felt by everyone. Many people become frightened and run outdoors. Some heavy furniture is moved. Some plaster falls. Trees sway.	4.9-5.4
VII	**Very Strong**: Most people are in alarm and run outside. Damage is negligible in buildings of good construction. Walls crack. Plasters fall.	5.5-6.1
VIII	**Destructive**: Damage is slight in specially designed structures. Considerable in ordinary buildings, great in poorly built structures. Heavy furniture is overturned.	6.2-6.9
IX	**Ruinous**: Damage is considerable in specially designed structures. Buildings shift from their foundations and partly collapse where ground begins to crack. Underground pipes are broken.	
X	**Disastrous:** Some well-built wooden structures are destroyed. Most masonry structures are destroyed. The ground is badly cracked. Considerable landslides occur on steep slopes.	7-7.3
XI	**Very Disastrous:** Few, if any, masonry structures remain standing. Bridges destroyed. Rails are bent. Broad fissures appear in the ground.	7.4-8.1
XII	**Catastrophic:** Virtually total destruction. Waves are seen on the ground surface. Objects are thrown into air.	>8.1

based on direct measurements of the size of seismic waves (height of the waves generated on the surface of earth scientifically called amplitude of ground motion), made with recording instruments. The largest earthquake ever recorded had a magnitude of approximately to the highest value on the Richter scale. The magnitude scale is made in such a way that the difference between two consecutive whole numbers on the scale means an increase of 10 times in the amplitude (the height of wave) of the earth's vibrations. It has been estimated that a tenfold increase in the size of the earth's vibration is caused by an increase of about 31.5 times in terms of energy. A quake of magnitude 5, for example releases 31.5 times more energy than one of magnitude 4. A magnitude 6 quake is almost 1000 times (31.5 x 31.5) more powerful in terms of energy released than a magnitude 4 quake.

Frequency of earthquakes

In the whole earth, earthquakes of one kind or another are known to take place every few seconds. But many of them are too slight to be felt by men. Really severe earthquakes take place every two or three weeks. On average, most of these originate beneath the oceans and cause little damage to life and property. Most earthquakes are small, and each year about 700,000 small earthquakes called **tremors** are recorded by instruments. Great earthquakes with magnitudes exceeding 8.0 occur about once every few years.

HIMALAYA–THE LIVING MOUNTAIN

The Himalaya was formed by the most recent mountain building activity (tectonic activity) in the earth's history and therefore it is called the youngest mountain on earth. The origin of the Himalaya began around 50 million years ago at the time when the north moving India first touched Asia. India pushed itself from near South Pole continuously for nearly 200 million years before it collided with Asia. Even after collision, India continued pushing Asia to the north and in the process India's leading edge was sliced, broken, folded and uplifted to form the youngest and the highest mountain range on our planet. The Himalaya was already a dominating mountain range and causing monsoon rain in South Asia as early as 17 million years before (France-Lanord and others 1993).

India (the Indian plate) is constantly moving to the north even at present and converges below Tibet by 20 mm annually. This convergence builds up a very large storage of energy in the Himalayan region over a period of time. The energy is stored by building up elastic strain or deformation in the rocks of the Himalaya and adjoining areas. When the accumulated energy exceeds the ultimate strength of the rock, the rock breaks and suddenly releases the accumulated energy as slip on faults. As mentioned earlier, scientifically, the travel of this energy through the earth in the form of seismic waves is called earthquakes. Such movement of rocks in most cases occurs along preexisting faults (breaks in earth's crust) which can be studied in the field.

Since the mountain building process is still under progress, the Himalayan and surrounding region is seismically one of the most active parts on earth. The earthquakes occurring in the Himalayan region are often greatly devastating and have killed large number of people in the past. Some of the largest continental earthquakes on record have been located especially along the Himalayan front. Perhaps earthquakes in the Hindukush–Himalay–Tibet region and its periphery have killed more people than in any other parts on earth. The region also includes the most densely populated countries of the world, and over one third of earth's population (over 2 billion) live in this region.

EARTHQUAKES IN NEPAL

Records of earthquakes since 1253 indicate that Nepal was hit by over 16 major earthquakes. However, the records may not be complete, and the data on loss of life and property may also be not very accurate. Out of these, the 1833 (magnitude 7.9) and 1934 (magnitude 8.3) earthquakes that occurred at an internal of 100 years were better recorded and were most disastrous. Particularly the effect was severe in the Kathmandu Valley. Statistically, the earthquake occurrence data of the last century shows that in average Nepal was hit by a big earthquake in every 12 years (Nakarmi 1997).

Nepal established its first seismic station in

1978 under the Department of Mines and Geology, His Majesty's Government of Nepal. Today it has 21 telemetric seismic stations covering the whole country with Kathmandu (Central Nepal) and Surkhet (Mid-Western Nepal) as base recording stations. Over the years, a great amount of data has been collected which are very useful for earthquake hazard mitigation. The record shows that during the period between 1994 and 1999, the average frequency of earthquakes (magnitude between 2 and less than 5) were approximately 10 per day. Earthquakes of magnitude between 6 and less than 7 were 1 in 6 years. Also, the total number of earthquakes (magnitudes between 2 and less than 7) per year between the years 1994 and 1999 were approximately 700, 900, 1500, 1700, 2200, and 1600 respectively (Fig. 5).

THE FUTURE GREAT CENTRAL HIMALAYAN EARTHQUAKE

An overdue event

Many earth scientists believe that longitudinally the entire 2,400 km long Himalayan arc can be segmented into different individual parts (200–300 km) which periodically break and move separately and produce mega-earthquakes (catastrophic earthquakes) in the Himalayan region. From east to west, the great earthquakes of Assam, India (1950), Shilong, India (1897), Nepal–Bihar, India (1934), and Kangra, India (1905) are the mega-earthquakes of the last century produced by the movements in different parts of the Himalaya arc, all with magnitudes around 8.0–8.7. There were also many intervening medium to large earthquakes that occurred in different sectors of the Himalaya which were smaller than those earthquakes, still quite devastating. When a sector of the Himalaya moves and produces earthquakes, it will take some time (from decades to centuries) to repeat the event at the same place.

Today, earth scientists are most concerned about the lack of occurrence of any great earthquake between Kathmandu in the east and Dehra Dun, India in the west during the past many centuries, and have named it the Central Gap. It is most likely that this segment of the Himalaya is due for a major break to trigger a mega-earthquake in the Himalaya. It is even suspected that it may be the greatest earthquake that we have so far experienced in the Himalaya in the past few centuries. The area closer to the epicentre will suffer the maximum damage. It is not only

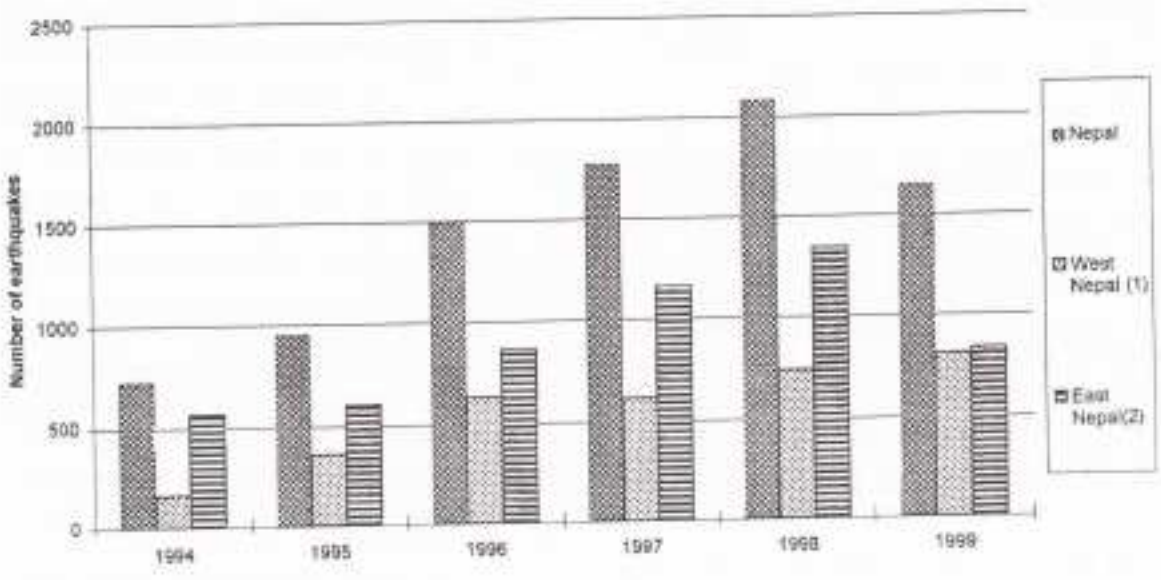

Fig. 5: Number of earthquakes occurring in Nepal between 1994 and 1999

the Himalayan region but also the adjacent north Indian plain (the most populous part of India) which will be heavily affected by this impending earthquake. Over100 million people may be at risk by this eminent future earthquake.

EARTHQUAKE SCENARIO FOR KATHMANDU VALLEY

The chaotic capital city of South Asia

After the establishment of democracy in Nepal in 1951, Kathmandu, the capital city of Nepal, started growing rapidly out of a small and quiet medieval town. The city particularly expanded very rapidly after the late seventies. Unfortunately, Kathmandu may be the only capital city in the region, which was allowed to grow to the present size and population (approx. 2 million) without any proper planning and vision. No roads, sewerage, public facilities such as parks and open spaces were planned in any part of the city. The whole city grew out of chaos. Most areas out of the city core were open rice fields till as late as the eighties. It was not too late for planned development in new growth areas to avert the chaotic growth. Unfortunately, nothing was done on a government level.

Today, the entire city has only a limited length of winding narrow roads and lanes. Most part of the city is inaccessible to ambulance, fire fighting equipment, heavy vehicles, excavators, and dumpers. There is also a severe shortage of water-supply in Kathmandu valley.

A majority of buildings in the city are unengineered, and there is no quality control from any agency on building construction. The national building code was only very recently enacted but yet to be implemented. The buildings so far constructed were at the owner's own risk. Even the quality of most public and government buildings is highly questionable. Therefore, most private and public buildings, hospitals, hotels, and schools are highly vulnerable to earthquakes.

WEAK GEOLOGICAL FOUNDATION OF KATHMANDU VALLEY

In the past, the Kathmandu Valley was occupied by a lake, some part of which may have existed at the central part of the valley as late as 5000 years before. The valley was therefore filled up by lake sediments and river deposits. The filling sediments are made up of clay, silt, sand and gravel. The maximum thickness of these sediments is over 600 m in some places. Recent drillings in these sediments have shown that the subsurface soil of central part of the Kathmandu Valley is very soft up to a depth of about 20 m. Buildings and other infrastructures built on such soft and thick soils are very vulnerable to the forces of earthquakes as compared to the structures built on top of hard rocks. Due to this thick soil cover, during an earthquake the buildings in the Kathmandu Valley are shaken very strongly than the buildings in the surrounding hills with rocky base. It is estimated that during an earthquake the central part of the Kathmandu Valley may be shaken 6–8 times stronger than in the surrounding hills (Pandey 1999; DMG 2000). This greatly endangers higher than two storied buildings.

EARTHQUAKE SCENARIO

Thus, the very weak geological condition of the valley and the poor construction practice has made Kathmandu the most vulnerable city in the country. If an earthquake similar to 1934 (Nepal–Bihar earthquake of Magnitude 8.3) occurs, Kathmandu is going to be very severely damaged. Based on various sources, Kathmandu Valley Earthquake Risk Management Project (Dixit and others 1999) has estimated that during such an earthquake there may occur approximately 40,000 deaths, 95,000 injuries, and 600,000 or more rendered homeless in the valley. A conservative estimate shows that 60–70 % of buildings in the valley will be damaged heavily. Residences are the most vulnerable structures.

The next major earthquake to affect Kathmandu Valley will bring an unprecedented disaster. The aftermath of the disaster will be extremely painful. The rescue operation will be greatly hampered, as there is no adequate equipment in the valley such as excavators, cranes and dumpers. The most densely populated old parts of the cities (Kathmandu, Patan, and Bhaktapur) with narrow lanes may become practically inaccessible perhaps for weeks after

disasters for any rescue operation. Road access to the valley will be cut off for weeks to months due to landslide blockage and bridge collapses. The airport in the valley may not be operative. All rescue equipment and relief materials have to be transported by air, probably only by helicopters. Rescue operation will be seriously hampered and painfully slow due to unavailability of mechanical equipment such as cranes, excavators, and dumpers. There will be severe water supply and sanitary problems. There will be great scarcity of firewood to burn dead bodies and fuel for cooking. Transportation within the valley will be most difficult, as many bridges will collapse and roads will be damaged. If the earthquake hits the Kathmandu Valley during the mid-monsoon or mid-winter period, the situation will be even worst. The continued unplanned and haphazard growth of Kathmandu Valley is contributing towards its development into a highly dangerous place to live. To add more pain and further worsen the above scenario, during such a large natural disaster, the management of the rescue and relief operation as well as law and order maintenance by the government is highly likely to fail.

PREPAREDNESS – THE URGENT CALL

Earthquakes as such do not kill people; the collapse of buildings kills them. Therefore, good house construction practice with strict implementation of building codes, improvement of narrow winding roads into wider roads, formulation effective disaster management plan and taking every precaution towards the earthquake disaster mitigation will certainly greatly help to minimize the loss of life and property. The action has to start today as the impending earthquakes may strike us anytime-tomorrow, next year, or after 20 years.

It may be emphasised here that the presentation of the above scenario is not to panic people but to provide information, and make them realise that earthquakes are inevitable in Nepal. They are frequently occurring natural phenomena in the country. One should remember that in recent history, Kathmandu was almost completely destroyed by two great earthquakes (1833 and 1934 earthquakes). It is therefore not a question whether a major earthquake will strike Kathmandu (or other parts of Nepal) or not, the question is: *when will it strike?* Scientists are not yet able to predict the time of occurrence of a future earthquake. Preparedness is the only way to minimise the impact of an earthquake disaster.

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Nepalese Geologists in Nation Building

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Geological challenges are part of life for people. Lifestyle and economy of the people is related to the availability of natural resources, environmental conditions, fertility of soil, slope gradient, and the stability of hill slope. People were using their own techniques and knowledge about the earth material, their utilisation, and protection on their own way since the beginning of the civilisation, but the systematic study on the geology of Nepal is not older than six decades.

Hooker (1854) is named as the earliest geologist visiting Nepal, but the Nepal Himalayas remained unexplored up to 1949. Systematic geological investigations intensified alongwith the opening of Nepalese boarder and the Nepal Himalayas became geologically well known sector of the Himalayan range within a short time. The controversies arise alongwith the intensities of the geological explorations. In the past three decades after the establishment of the Department of Mines and Geology by His Majesty's Government of Nepal and the establishment of the Central Department of Geology in Tribhuvan University, the activities of Nepalese geologists are in progress to find out the geological facts and their utilisation for the reduction of the controversy on the geological and tectonic interpretations. After the establishment of the Nepal Geological Society (NGS) in 1980, the activities of the geologists in the region have taken a new speed. Activities of the geologists and the scientific papers are published annually in the Journal of the Society. The results of the new scientific research are presented in different national, regional as well as international seminars organised by the Nepal Geological Society and the Department of Geology of Tribhuvan University.

Nowadays, Nepal is well known geological garden for the geologists of all over the world. The mystery of the highest peak of the world which was developed under the Tethys sea in the geological history is inspiring the geologists for further research. Excellent rock outcrops exposed along the mountain slopes, river banks, and trekking trails are inviting many geoscientists of different countries. Geoscientists from Nepal as well as overseas are actively involved in the following scientific researches:

- Tectonic and mountain building processes,
- Structural geological features,
- Earthquake and seismicity,
- Palaeontology,
- Geochronology,
- Reconstruction of earth history, and
- Intrusion and metamorphism.

Besides the scientific research, the application of geological knowledge is very much concerned to the people of Nepal. Most of the people in Nepal still believe that the geologists are the persons who are supposed to know about the mineral reserves. Many of them believe they know about the usefulness of the minerals to the human being. Only a few peoples know that geologists can prepare geological maps, which are essential for different purposes. Geological framework of a particular area has a significant influence on the lifestyle and economy of the people. Before thinking about the different developmental activities in any particular area the geological information is the prerequisite. Geological mapping is one of the major tasks of the geologists in Nepal. The geological map is a graphical representation or documentation of the geological framework of the area. Such maps also include the location of the economic mineral deposits, major weak zones, different types of rock and soil etc. At present, most of the geological maps are purpose-specific. The scale

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of geological maps prepared for different purpose is different. Information content of such maps varies with the scale of the maps and the purpose also. Mineral exploration and the geological mapping have been the major task of the geologists in Nepal. The opportunities as well as field of responsibility of geologists has been extended alongwith the increasing number of geologists in Nepal. Demand of geologists in different nation-building activities in Nepal is increasing, but the academic institutions are still providing the conventional geology only. The geologists have to upgrade their knowledge in different related fields, so that they can face the new competition in availing opportunity and participate more effectively in nation building.

Geologists play a key role in the following fields:

- Mineral exploration;
- Petroleum exploration;
- Ground water exploration, extraction and protection;
- Civil engineering activities;
- Land use planning;
- Natural hazard and risk management;
- Environmental protection;
- Solid waste management; and
- Agricultural engineering.

A considerable number of historical small-scale iron, copper, lead, zinc, cobalt, nickel, gemstone, and some other industrial minerals as well as construction materials, mining, and quarry sites are known in Nepal. Duty of the geologists from the very beginning has been to get the proper information about the reserves, their quality, and economic viability. Systematic geological study and the mineral exploration in Nepal has begun with the establishment of the Department of Mines and Geology (DMG) under the Ministry of Industry of His Majesty's Government of Nepal. The DMG has identified a considerable number of large, medium, and small size economic and potentially economic mineral deposits in different parts of Nepal.

Sedimentary formations of the Terai and Chure belt of Nepal are the probable places for the petroleum and gas deposits. Nepalese geologists are also engaged in a systematic petroleum exploration activities in these belts. Petroleum Exploration Promotion Project in the DMG has conducted geological and geophysical studies for identification of possible structural traps and source rocks for assessing the potentiality of the petroleum resources in the country.

Groundwater is also a very important natural resource in Nepal. Many of the perennial streams and rivers originated from the mountainous region have no snow-fed source. The only source of water in such streams and rivers is the groundwater preserved in the mountain aquifers. Although a number of large rivers are flowing through the Terai in Nepal, groundwater is still only the source of drinking water. Groundwater extraction for irrigation is very popular in many parts of the Terai. Recognition, study, and protection of such aquifers is very essential. Geologists can play a key role in groundwater exploration (recognition of aquifer zones) as well as groundwater extraction, preservation, and protection against contamination. A considerable number of geologists are employed in the groundwater- related job. This is one of the fields for the geologist to contribute their sound knowledge. The knowledge in advanced tools and techniques developed in recent years in many developed countries helps them in the field of recognition of the groundwater reserve and its exploration.

Every civil engineering activity in the country requires a plenty of geological knowledge. An engineering geologist is a geologist who knows about the civil engineering structures and translates the geological facts in civil engineering practices. Geological data are vital for the identification of the project, its feasibility (both economic and safety aspects), their design, proper construction, and maintenance. Nowadays involvement of an engineering geologist in every team of civil engineers is the must. Every engineering geologist must be a geologist at first, but not all the geologists are engineering geologists. The geologists who are willing to work for the civil engineering projects should

have to think themselves whether their knowledge in the required field is enough. If not, they should not hesitate to learn from others at first, so that the project and the investors who have given the job should not have to bear the loss.

Involvement of geologists in land use planning is very essential, but still the concerned authorities in Nepal are not taking the fact seriously. The effectiveness of the land use planning depends on the geological base. A good geological map along with the topographic map should be the first material for the planners.

Nepal is situated in one of the highest disaster-prone belts of the world. Many of the disasters are directly or indirectly related to the geological conditions. Soil erosion, slope failure, landslide, debris flow, and earthquake are the most prominent natural hazards in Nepal. Weaker the rocks greater the hazards and higher the risk. Hazards and risk to the life and property increase with the increasing geologically weak zones, such as faults, folds, and shear zones. Identification of the natural hazard and risk management is impossible without the geological know-how. Only a few geologists are dealing with such problem. A number of geologists should enhance their knowledge in this field, so that they are able to deal with such prominent challenges in Nepal.

Protection of the environment against increasing degradation is another challenging task. Continuation of the environmental degradation going on in the country may change our beautiful mountain into a desert. Geological knowledge is vital for preventive as well as mitigation measures to arrest such degradation. The Possibility of degradation increases with increasing geologically weak zones. Our groundwater wealth should be protected against contaminants, so that we could leave our subsurface environment clean. Although involvement of geologists is most essential in such activities in Nepal, the responsible authorities have not yet taken the fact so seriously. Geologists should also strengthen their knowledge in such fields so that they could take part in a team for the environmental protection.

Solid waste management has become a big challenge in the major cities of Nepal. The challenges are growing with the growth of the cities. Geological knowledge is the prerequisite to find the proper site for the disposal of the solid waste. Geologists can play a key role in solid waste management activities.

Nepal is an agriculture-based country. Fertility and productivity of the soil is one of the major parameters in such an agrobound economy. The soil is either the residual or transported. The residual soil is completely weathered product of the parent rock. Intensity of weathering increases with the availability of the geologically weak zones and the mineral composition of the parent rock. Thickness of the residual soil is determined by the slope gradient as well as mineral composition of the parent rock. Geological depressions are the major sites for the deposition of the transported soil. Colluvial soils are the transported soils, which are adjacent to the source area. Geological depressions as well as basins are the places where the colluvial soils transported under the gravity could be deposited. Alluvial soils are the transported soil deposited by the rivers in the lowland as well as along the riverbank. Most of the rice fields in Nepal are in the alluvial soil. A branch of geology, which helps to face the geologically initiated challenges in agriculture is called agricultural geology. Although quite a few geologists are involved in construction of irrigation canals in the groundwater extraction for irrigation purposes, no one is specialised in agricultural geology in Nepal nor any of them is employed for the job. Agriculture-based economy of Nepal demands for the attention of the responsible authorities to implement the geological know-how. Quite a number of geologists should have to be trained in agricultural geology, so that they could contribute to agriculture.

Knowledge on applied geophysics, applied geochemistry, geomechanics, and geoinformatics (computer-added geology) is most important to make the judgement of the geologist more precise and efficient. The technical advancement has

made the geologists efficient to know the matter of the millions of years to the matter of milliseconds. The geologists once recognised as the persons who could explore the economic mineral reserves can contribute in nation building in various aspects in Nepal.

Challenges in Geological Sciences in the 21st Century

Krishna P. Kaphle, Senior Divisional Geologist
Department of Mines and Geology

Since the time of Stone Age human beings are making use of all types of natural resources. By the time of Iron and Bronze Age, they started exploiting various types of natural resources like minerals, water, land and forests, and making multiple use of them for their benefit and comfort. As we all know that nowadays rocks and minerals are not only used as construction materials, industrial or chemical raw materials, ornaments, sources of various types of metals and fossil fuels, but also used for nuclear energy, optical and electrical appliances, chemicals, and modern medicine. At present, these mineral commodities are becoming the essential part of modern life. However, if we go on exploiting these nonrenewable resources as we are doing now, they will be exhausted one day. Therefore, to fulfill the future demands, we have to think over the alternative resources. Moreover, instead of looking for resources that we are using traditionally which are not around in our region we should be able to face the challanges of capability of using available resources in our region in the new millenium. (Example: maximum use of water for energy rather than oil).

To fulfill the present demand and competitive world market, in many cases, unplanned and haphazard mining and exploitation practices of mineral commodities and other natural resources have increased significantly, causing global environmental pollution since the beginning of 20th century. This burning environmental issue was realised by the people only from last 2 or 3 decades.

The other causes of environmental degradation are unplanned urbanisation, improper developmental activities, rapid industrialisation, uncontrolled landuses and haphazard disposal of all kinds of waste (industrial, chemical, nuclear, hospital, and municipal etc.). All these are causing air, water, and ground pollution, and ultimately bringing the problem of health hazard. It has become not only a regional but also a global problem. Nowadays the people also realised that it is their responsibility to carry out sustainable developmental activities, preserve natural environment, keep the ecological balance, and maintain the friendly eco-system.

Every country has environmental problems but the spectrum of the problems is different. The environmental degradation in the industrialised nations is largely chemical. They are responsible for bulk of the emission that causes greenhouse effect. On the other hand, the environmental degradation in the developing countries like ours is largely physical.

At a global level, pollution is caused by burning of fossil fuels which increase the CO_2 content bringing about global warming or what is generally known as the greenhouse effect. As a result, climate change is taking place. Similarly, people are also conscious about chlorofluorocarbon that is destroying the ozone layer in the stratosphere, and consequently causing the health hazard to human life.

In this context, the challenges to geoscientists in the 21st century are tremendous. Some of the important ones are:

- to raise awareness among the people to live in harmony with the nature;

- to move from the traditional geological works to adaptive pattern for sustainable developmental work;
- to look for new alternative sources of energy and minerals, particularly renewable energy resources in our region;
- to face the challenge of conservation of natural resources rather than exploitation of them; and
- to carry out researches and development of appropriate technology for optimum use of natural resources for the benefit of people of our region rather than copying or importing them from the developed countries as they may not be suitable for our region.

RECOMMENDATION

Thus, geoscientists should focus on the interdisciplinary approach to face the challenges of the new millenium. The regional cooperation is very much essential in order to develop our South Asian Region. We have various forums as such but continued follow up is essential to make them effective.

(This paper was presented by the author in a special session in GEOSAS-III in Lahore, Pakistan, in September 2000.)

Geological mapping works of the Department of Mines and Geology

J. N. Shrestha
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INTRODUCTION

Development of a country depends much on the development of its natural resources. Mineral-based industries can play a role, sometimes vital, in the economic growth of the country. Geological mapping is the first and the most important step in prospecting for any type of mineral.

In Nepal, there exist huge natural resources like water and minerals, but their identification, exploitation, and utilisation yet to be carried out. Over all the living conditions of the people of this area are miserable.

To utilise the existing mineral resources and to plan the basic infrastructures, geological information has to be collected and presented in usable forms. With this in view, HMG has started systematic geological mapping and publication of maps. However, even though most accessible parts of the country are covered by small-scale geological maps, only a few sheets are published in regional scale, which is the basic scale for regional developmental planning and mineral prospecting.

As the only governmental organisation entrusted with geoscientific investigations within Nepal, the Department of Mines and Geology (DMG) is engaged in systematic geoscientific investigation and mineral exploration of the country in order to fulfill the aim of His Majesty's Government of Nepal to uplift living standard of people of Nepal through rapid industrialisation by utilisation of national natural resources. In this context, the DMG has extensively conducted geological mapping and other researches including prospecting and exploration of various metallic, non-metallic, and fuel resources throughout Nepal.

As a result of painstaking works of the DMG, all accessible parts of the country are covered by the first generation geological maps of the regional scale. The whole country is covered by geological maps of various scales. Now, the DMG has embarked upon upgrading of previous maps and carrying out specialised dedicated maps such as environmental and engineering geological maps of specific areas.

The maps prepared by the DMG provide basic data on geology and structures of the area and hence are useful for planning of infrastructures such as dams, bridges, roads, and canals as well as for mineral prospecting. As the developmental activities grow the demand for various types of geological information grows rapidly. For this purpose, the DMG endeavours to spread knowledge about existing geological information in the country to both national and foreign entrepreneurs and public in general.

GEOLOGICAL MAPPING IN THE NEPAL HIMALAYAS

Brief History

History of geological study in the Himalayas started in the late 19th century with works of Hooker (1854), Medlicot (1875), Oldham (1893) etc. However no systematic work was done. If one makes exception to a few sporadic observations made by foreign geologists, systematic study of the Nepal Himalayas was started only after 1950. Hagen (1969) carried out first systematic geological study of the country in fifties. Fuchs and Frank (1970), Talalov (1972), Hashimoto (1973), Stöcklin and Bhattarai (1977), Bordet (1961) etc have made either reconnaissance survey of the whole country or detailed work in some of its parts. systematic geological survey was started by the Nepalese geologists only in late sixties.

Regional Geological Mapping

Nepalese geologists of the then Nepal Geological Survey (NGS) had started systematic geological mapping of the country since the late sixties, and then was continued later on by the DMG. The history of geological mapping can be divided into the following four distinct phases.

Phase 1: Geological mapping of the country was started by the Nepalese geologists at first with sporadic coverage of secluded areas. However, with growth of the developmental activities, an acute need of geological information was felt and hence it was deemed necessary to map the whole country. With this in view, a programme of systematic coverage of the whole country by regional geological mapping was started in 1967. This project continued the work up to 1980.

During this period of 13 years, most of the easily accessible parts of the country, mainly in the central Midlands (Lesser Himalayas) and Churia Range, were covered by regional geological mapping of the scale 1"= 1 mile. The topographic maps of Nepal published by the Survey of India in the scale 1"= 1 mile were used as base maps for this survey. At present, out of the central and southern parts of the country, only a few sheets covering the Churia ranges in the eastern parts of the country (east of Hetauda) remain to be covered by the regional geological mapping. After 1980, compilation and publication of the geological maps based on the completed regional geological mapping was started.

Phase 2: Thirteen years of intensive geological mapping have produced an immense wealth of geological information regarding the geology of the Lesser Himalayas and the Churia Range. All information was collected in separate map of 1"= 1 mile scale. The quality and quantity of information in each sheet varied greatly. Since they were the first base maps, quality of maps produced in latter years were definitely better than those produced earlier, when there was virtually no information. All this necessitated thorough analysis and examination of all maps before any compilation work to produce geological maps could be undertaken. Hence during 1980–85 field data were checked, analysed, interpreted, and compiled for printing. Thus, in the 2nd phase of the geological mapping, fieldworks were undertaken to check in site-related geological data.

In this endeavour, stratigraphy and tectonic structure of the Lesser Himalayas and Siwaliks was established and a unified stratigraphic scheme of the region was proposed. No doubt, there are still some contradictions and unsolved geological problems to which the mapping section of the DMG is well aware of. Such specific problems can be solved only by more detailed, dedicated, and thematic works in the future. To this end the DMG is well committed.

During the early 1980s, with the progress in map compilation works, publication of colour geological maps was started. First colour geological map of Nepal, prepared and printed in Nepal was published in 1983. Since then 5 sheets are published covering whole of the Lesser Himalaya, Churia Range, and Terai Belt of Nepal. Of the 147,000 sq km area of the country, 93,000 sq km area has been covered by the 5 maps. Each sheet roughly corresponds to a development zone of Nepal. Name of the sheet, date of publication, and other details are given in Table 2. All maps are in 1:250,000 scale.

Table 2: Geological Maps of Nepal

S. N.	Name of Map Sheet	Year of Publication
1.	Geological map of Central Western Nepal	1983
2.	Geological map of Eastern Nepal	1984
3.	Geological map of Central Nepal	1985
4.	Geological map of Mid Western Nepal	1988
5.	Geological map of Far Western Nepal	1988

Based upon the data of these geological maps published by the DMG and data from other maps published elsewhere, a 1:1,000,000 scale geological map covering whole Nepal was prepared. This map was published by ESCAP in 1993.

Phase 3: After of geological field mapping, compilation, and publication of maps of the Lesser Himalaya, Churia, and Terai area of Nepal, efforts were geared up to map physically more difficult high-altitude remote areas of the Higher Himalaya and Tibetan Tethys Himalaya along the northern border of Nepal. The period of 1985–1990 saw geological mapping works concentrated in the Higher Himalayan area of Far Western and Eastern Nepal.

Work in the Tibetan Tethys sedimentary basin began in 1990. This area, geologically different from the rest of the country, was in the last due to two reasons: (1) it is the most remote and geographically difficult area and (2) it has fossiliferous rocks whereas rest of Nepal is made up of virtually unfossiliferous metamorphic rocks.

The area in general is above 10,000 ft in the northern watershed of the Higher Himalayan Range. Due to highly dissected terrain without population, high altitude, and difficulties in mobilisation, geological mapping in this area is in the form of reconnaissance survey conducted along major river valleys and a few high-altitude tracks crossing through passes at 17–18,000 ft

Based upon the data of these geological maps published by the DMG and data from other maps published elsewhere, a 1:1,000,000 scale geological map covering whole Nepal was prepared.

Phase 4: Since 1992 the DMG has started the reassessment of old published and unpublished data, recompilation and publication of geological maps of the areas of Central Western Nepal in continuation with the area covered by maps published by the Mineral Exploration Development Board (MEDB)/DMG. During the last 9 years, more than 20 sheets were remapped and 9 sheets of second generation geological maps in the scale of 1:50,000 were published. This work is in progress to date.

Results

Geological mapping works conducted to date:

Total area of Nepal	147,181sq km
Maps compiled and published	93, 000 sq km
Reconnaissance-scale maps completed during 1985–90	11,000 sq km
Remapped to prepare second generation maps	14,375 sq km
Second generation maps published, scale 1:50,000	5,625 sq km
Terai and inaccessible areas (not mapped)	27,500 sq km

A list of all published geological maps is given below.

S. N.	Map sheet	Scale	Publication year
1	Geological Map of Nepal	1:1,000,000	1980
2	Geological Map of Kathmandu and Central Mahabharat Range	1:250,000	1980
3	Geotectonic Division and Mineral Deposits of Nepal	1:200,000	1980
4	Photogeological Map of Part of Central Nepal	1:100,000	1982
5	Geological Map of Central Western Nepal	1:250,000	1983
6	Geological Map of Eastern Nepal	1:250,000	1984
7	Geological Map of Central Nepal	1:250,000	1985
8	Geological Map of Mid Western Nepal	1:250,000	1988
9	Geological Map of Far Western Nepal	1:250,000	1988
10	Geological Map of Nepal	1:1,000,000	1993
11	Mineral Resources Map of Nepal	1:1,000,000	1993
12	Geological Map of Nepal	1:1,000,000	1996
13	Geological Map of Part of Tanahun, Gorkha, and Nawalparasi Districts (Toposheet 72A/5)	1:50,000	1997
14	Geological Map of Part of Tanahun and Kaski Districts (Toposheet 71D/4)	1:50,000	1997
15	Geological Map of Part of Syangja, Kaski, and Tanahun Districts (Toposheet NO 62P/16)	1:50,000	1999
16	Geological Map Parts of Tanahun and Nawalparasi Districts (Toposheet No.72 A/1)	1:50,000	1999
17	Geological Map of Parts of Syangja, Palpa, and Tanahun Districts (Toposheet No 63 M/13)	1:50,000	1999
18	Geological Map of Parts of Parbat, Baglung, and Gulmi Districts (Toposheet No 62 P/12)	1:50,000	2000
19	Geological Map of Parts of Gulmi and Baglung Districts (Toposheet No 62 P/8)	1:50,000	2000
20	Geological Map of Parts of Palpa, Syanjga, and Gulmi Districts (Toposheet No 63 M/9)	1:50,000	2000
21	Geological Map of Parts of Palpa, Arghakhanchi, and Gulmi Districts (Toposheet No 63M/5)	1:50,000	2000

How to procure maps

All maps and reports are made available to governmental agencies, consultancies, NGOs, INGOs, other relevant organisations, and the general public under the prescribed policy of DMG. Published maps can be bought at government approved fixed rates from the following agents appointed by the the DMG:

– Nepal Geological Society, Lainchaur; and

– Maps of Nepal, Naya Baneshwor.

All published and unpublished maps and reports can be made available to other governmental agencies and general public through written permission of the Director General of DMG with or without cost.

नेपालमा पेट्रोलियम अन्वेषण

उपेन्द्र मान सिंह प्रधान

पृष्ठभूमि

दुई ठूला दुइाको बीचमा फलेको तरुल भै नेपाल दुई ठूला राष्ट्र बीचको एक सानो हिमाली राज्य हो । समुद्र देखि करिब ६०० कि. मि. टाढा उत्तरमा अवस्थित भू-परिवेष्ठित राष्ट्र नेपाल विकासको खोजीमा छ । नेपाल कृषि-प्रधान देश तथा जल सम्पदामा धनी मानिन्छ तर पञ्चायत कालदेखि प्रजातन्त्रको आगमन पश्चात् पनि राष्ट्रनिर्माणका काममा संतोषजनक प्रगति चाहिँ हुनसकेको छैन । यस्तो परिस्थितिमा राष्ट्र निर्माणका लागि अन्य विकल्पको खोजी अपरिहार्य छ । विकल्पको नाममा हुन सक्ने तेल तथा प्राकृतिक ग्यासको खोजीलाई सक्रीयताका साथ अगाडि बढाउने हो भने एउटा मात्र तेलको कुवा फेला पार्न सके पनि यसबाट देश निर्माणको काममा ठूलो मद्दत मिल्न सक्ने देखिन्छ। नेपालमा सालाखाला प्रति दिन १०,००० ब्यारेलको हिसाबले पेट्रोलियम पदार्थ खपत हुने गरेको र नेपालको वैदेशिक मुद्रा आर्जनको १ तिहाई भाग पेट्रोलियम पदार्थको आयातमा मात्र खर्च भइरहने गरेको सन्दर्भमा देशमा पेट्रोलियम उत्पादन गर्न सकिएमा देशको मागको आपूर्ति भई राष्ट्रको अर्थतन्त्रमा ठूलो टेवा मिल्न सक्ने विश्वास राख्न सकिन्छ ।

पेट्रोलियमको उत्पत्ति

पेट्रोलियम भनेको हाईड्रोकार्बन र केही अन्य कम्पाउण्ड मिश्रित एक तरल पदार्थ हो । हाईड्रोकार्बन भन्नाले Paraffins, Nepthans, Aromatic आदि पदार्थलाई जनाउँछ । अन्य कम्पाउण्डमा Sulphur, Nitrogen, Oxygen आदि तत्वहरु मिसिएको पाइन्छ । पेट्रोलियमको उत्पत्ति Inorganic र Organic Theory मा आधारित भएकोले यी दुई Source materials बाट नै तेल बनेको विश्वास गरिन्छ । Organic source बारे पर्याप्त तथ्यहरु पाइएको देखिन्छ । Organic Theory अनुसार समुद्रको पीधमा थिग्रिएको sediment मा रहेका धुप्रै organic matters (plant and animal) मा भौगर्भिक समय देखिको ताप, चाप, Bacteria र Chemical decomposition आदिको कारणले तेल बनेको हो । यसरी बनेको तेल सबै एकै ठाउँमा नै रहिरहन्छ भन्ने हुँदैन । बरु, धेरै टाढा बगेर रिजरभ्वायरको गुण भएका चट्टानहरु (sandstone, limestones) मा जम्मा हुन जाने हुन्छ । यसरी रिजरभ्वायर चट्टानहरुमा जम्मा भएको पेट्रोलियम पदार्थलाई नचुहिने चट्टानहरु (Seal rocks) अथवा Fault आदिले बताउति बग्न नपाउने गरी रोकिराखेका हुन्छन् ।

नेपालमा तेल तथा प्राकृतिक ग्यासको इतिहास

नेपालका विभिन्न भागमा तेल तथा प्राकृतिक ग्यासको सङ्केत फेला परेका छन् । काठमाडौं उपत्यकामा धेरै अघिदेखि पानीको लागि कुवा खन्दा ठाउँ-ठाउँमा पानी सँगै मिसिएर ग्यास निस्किएको र कतिपय मानिसले सो ग्यासलाई पाइपलाइनद्वारा उपयोग गर्दै आएका छन् । मुस्ताङ जिल्लाको मुक्तिनाथ क्षेत्र र दैलेख जिल्लाको श्रीस्थान, नाभिस्थानका खोलाहरु र आसपासका क्षेत्रहरुमा ग्यास निस्किरहेको र दैलेखको पादुकास्थानमा ग्यासको साथै तेल पनि बराबर निस्किरहेको पाइएको छ । ती क्षेत्रहरु पवित्र तीर्थस्थलको रुपमा प्रख्यात छन् ।

खानी तथा भूगर्भ विभागले सन् १९७८ देखि JICA को सहयोगमा काठमाडौं उपत्यकामा अवस्थित प्राकृतिक ग्यासको करिब २६ वर्ग कि. मि. क्षेत्रमा विस्तृत अनुसन्धान तथा अन्वेषणको कार्य संचालन गर्दै आएको छ। उपत्यकामा ग्यासको उपस्थिति बारेका अध्ययन तथा उपादेयता सम्बन्धी कार्यमा UNDP को सहयोग पनि प्राप्त भएको थियो । यो ग्यासलाई सिलिण्डरमा भरी बिक्री-वितरण गर्न सम्भव नभएकाले पाइपलाइनबाट नै वितरण गर्नुपर्ने देखिन्छ । अनुसन्धानबाट पर्काल गरिएको ३० करोड घन मिटर ग्यास गार्हस्थ्य तथा औद्योगिक प्रयोजनमा प्रयोगगर्न सकिने देखिएकोले खानी तथा भूगर्भ विभागले यस ग्यासको प्रवर्धनका लागि निजी क्षेत्रबाट प्रस्तावको लागि सूचना समेत आह्वान गरिसकेको छ ।

भौगर्भिक बनोटको हिसाबले उच्च हिमाली भागको Tethys Sediment बाट उत्पादन भएको मुक्तिनाथ ग्यास पेट्रोलियम अन्वेषणको दृष्टिकोणले महत्वपूर्ण भएता पनि अति विकट उच्च हिमाली भागमा भएको कारण अन्वेषणको लागि समयको पखाँइमा छ ।

करिब ४ दशक अघि सुदूर पश्चिम नेपालको दैलेख जिल्लामा पर्ने पादुकास्थानको जमिन मुनिबाट पेट्रोलियम पदार्थ अर्थात् तेलको चुहावट भएको र स्थानीय मानिसको महतबाट सङ्कलन गरिएको उक्त तेललाई काठमाडौं ल्याई खानी तथा भूगर्भ विभागको सङ्ग्रहालयमा नमूनाको रुपमा राखिएको छ । दैलेख जिल्लाको श्रीस्थान, नाभिस्थान, र पादुकास्थानमा निरन्तर रुपले प्राकृतिक ग्यास निस्किरहेको तथा ग्यास आफैमा बल्ने गुण भएको कारणले विगतको दशकदेखि नै धार्मिक दृष्टिकोणबाट ज्वाला देवीको नामले

प्रख्यात भई उक्त ठाउँमा मन्दिरहरुको समेत निर्माण भई पूजा-आजा गरिने गरिएको छ ।

महाभारत क्षेत्रको दैलेखबाट बेसा-बेसा सङ्लन गरी रासायनिक विश्लेषण समेत गरेको उक्त तेल तथा प्राकृतिक ग्यास परिवर्तित चट्टानको अति गहिराइबाट बनेको Fault बाट निस्किएको र यसको सोर्स र रिजरभ्वायर नेपाल हिमालयको दक्षिणी समतल मैदान अर्थात् तराईको भू-सतह मुनि भएको Palaeogene Beds हुन सक्ने अनुमान भूगर्भविद्हरुले गरेका छन् । यस अलावा, तराई तथा चुरे श्रृङ्खलाका विभिन्न खोलाहरुमा पनि ग्यास देखिएको छ । तसर्थ, नेपाल अधिराज्यको सम्पूर्ण तराई तथा चुरे श्रृङ्खला पेट्रोलियम अन्वेषणको लागि अति महत्वपूर्ण छ ।

नेपालमा पेट्रोलियम पदार्थको सम्भावना

सम्पूर्ण हिमालय र दक्षिणको Gangetic Plain को भौगर्भिक बनौटलाई हेर्ने हो भने पूर्वमा भारतको आसाम र पश्चिममा पाकिस्तानको पोतवार र बीचमा रहेको नेपाल हिमालय र तराईको भौगर्भिक इतिहास समान रहेको पाइन्छ । पाकिस्तानको पोतवार र भारतको आसाममा धेरै समयदेखि पेट्रोलियम पदार्थको सफल अन्वेषण तथा उत्खनन् कार्य हुँदैआएको छ । नेपालको सुदूर पश्चिममा पर्ने दैलेखमा तेल तथा प्राकृतिक ग्यासको सङ्केत पाइएको र अन्य केही ठाउँहरुमा पनि ग्यासका सङ्केत देखापरेका छन् । यसरी नेपालमा पनि पेट्रोलियम पदार्थ (हाइड्रो कार्बन)को सङ्केत पाउनु र नेपालको भौगर्भिक बनौट तेलको उत्खनन् गर्ने छिमेकी राष्ट्रहरुको पोतवार र आसामको भौगर्भिक बनोटसित मिल्नुले नै नेपालमा पनि पेट्रोलियम पदार्थ हुनसक्ने सम्भावनालाई पुष्टि गरेको छ ।

पेट्रोलियम अन्वेषण परियोजनाको स्थापना

खानी तथा भूगर्भ विभागले राष्ट्र निर्माणको काममा टेवा पुऱ्याउने उद्देश्यले खनिज सम्पदाको अलावा तेल तथा प्राकृतिक ग्यासको अन्वेषण कार्यको प्रारम्भ गरिसकेको छ । पेट्रोलियम अन्वेषण प्राविधिक दृष्टिकोणले ज्यादै गहन र जटिल भएको हुँदा सो कार्य सीमित श्रोत र साधनबाट मात्र सम्पन्न नहुने कुरालाई दृष्टिगत गरी विभागले अन्तर्राष्ट्रिय सहयोग तथा सहभागिताको प्रयास र प्राप्ति समेत गर्दै आएको छ । यस अनुरुप सर्वप्रथम २०३६।३७ मा अन्तर्राष्ट्रिय विकास संस्था विश्व बैंकको (प्राविधिक र आर्थिक) सहयोगमा सम्पूर्ण तराई तथा चुरे श्रृङ्खलामा करिब ४८,००० वर्ग किलोमिटर क्षेत्रफलको एरोम्याग्नेटिक सर्वेक्षण कार्य सम्पन्न भयो । यस एरोम्याग्नेटिक सर्वेक्षणको परिणाम सकारात्मक र उत्साहजनक भएकोले पेट्रोलियम क्षेत्रमा अन्वेषण कार्यलाई प्राथमिकताका साथ सुचारुरुपले संचालन गर्दैजान खानी तथा भूगर्भ विभागले २०३९ सालमा आफ्नै सङ्गठन भित्र पेट्रोलियम अन्वेषण परियोजनाको स्थापना गऱ्यो ।

परियोजनाका क्रियाकलाप

यस परियोजनाले आफ्नो स्थापना कालदेखि नै नेपाल अधिराज्यको दक्षिणी भू-भागमा पर्ने पेट्रोलियमको लागि महत्वपूर्ण देखिएको सम्पूर्ण तराई तथा चुरे श्रृङ्खलाका साथै महाभारत श्रृङ्खलाको केही भागमा पेट्रोलियम अन्वेषण कार्य गर्दैआएको छ । अन्वेषण कार्यको दौरानमा श्री ५ को सरकारको आन्तरिक श्रोत र साधन तथा नेपाली प्राविधिकहरुबाट २,१०० कि. मि. जियोलोजिकल सेक्शन मेजरमेण्ट, २,१०० कि. मि. पेट्रोजियोकेमिकल स्याम्पलिङ तथा २२,५०० कि. मि. ग्रामिटी सर्वेक्षण कार्यहरु सम्पन्न गरिसकेको छ । यस अलावा विदेशी सहयोगबाट गरिनु पर्ने अन्वेषण कार्यको क्रममा हालसम्म ४८,००० वर्ग कि. मि. एरोम्याग्नेटिक सर्वेक्षण, ६०,००० वर्ग कि. मि. फोटो जियोलोजिकल स्यापिङ्ग तथा ५,००० लाइन कि. मि. भन्दा बढी साइस्मिक सर्वेक्षण कार्य सम्पन्न भइसकेको छ । पूर्वी नेपालको अन्वेषण खण्ड नं. १० (विराटनगर) मा अन्तर्राष्ट्रिय तेल कम्पनी (शेल र टाईटन) ले ३,५२० मिटर गहिराइसम्म एउटा इनार (ड्रिलिङ्ग) खन्ने कार्य समेत पूरा गरेको छ । साथै सुदूर पश्चिम नेपालको दैलेखबाट सङ्कलित ग्यास तथा तेलका नमूनाको भू-रासायनिक विश्लेषण गर्नुका साथै विगतका वर्षहरुमा सम्पन्न भौगर्भिक तथा भू-भौतिक कार्यको आधारमा थप भौगर्भिक तथा भू-रासायनिक कार्य गरी सोर्स, सील र रिजरभ्वायर चट्टानका नमूनाहरु विश्लेषण गरी सोको प्रतिवेदन पनि तयार गरिसकेको छ ।

पेट्रोलियम अन्वेषण एक जोखिमपूर्ण कार्य

पेट्रोलियम अन्वेषण कार्यको लागि करोडौं रुपैयाँको धनराशी र अत्याधुनिक प्रविधिको आवश्यकता पर्ने हुन्छ र यो कार्य गर्दा पेट्रोलियम पाइने निश्चितता नहुने भएकोले सम्पूर्ण लगानी डुबनसक्ने सम्भावनालाई नकार्न सकिन्न । तेलको इतिहासको तथ्याङ्कलाई हेर्दा १० देखि १२ वटा इनार (ड्रिलिङ्ग) खन्दा १ वटा इनारमा मात्र तेलको भण्डार पाइनेगरेको छ भने एउटा इनार खन्न करिब ८ देखि १० मिलियन यु. एस. डलर जति खर्च हुन सक्छ । हालको अवस्थामा यस्तो जोखीमपूर्ण कार्य श्री ५ को

सरकारको आफ्नै सिमीत श्रोत र साधनबाट गर्न असम्भव प्राय: नै छ । तसर्थ प्राविधिक तथा आर्थिक दृष्टिबाट सम्पन्न, विकसित राष्ट्र र संस्थाहरुमार्फतबाट मात्र पेट्रोलियम अन्वेषण तथा पेट्रोलियम उद्योगको काम गर्नु-गराउनुपर्ने हुन्छ ।

कानूनी प्रावधान

विदेशी तेल कम्पनीले आफ्नो ठूलो धनराशी जोखीमपूर्ण तरिकाले लगानी गर्नु पर्ने भएकाले तेल पाइएका खण्डमा आफ्नो सम्पूर्ण लगानी समेत उठाई अधिकतम फाईदा लिन इच्छुक हुन्छन् । तसर्थ कम्पनीको स्वार्थको पनि संरक्षण गर्ने र देशको हितको पनि सुरक्षा गर्ने दृष्टिकोणले श्री ५ को सरकारले नेपालमा पेट्रोलियम ऐन, नियमहरु र नमुना पेट्रोलियम बंडफाँड सम्झौता (Model Production Sharing Contract) को तर्जुमा गरेको छ । विश्व बजारमा तेलको मूल्य घटबढ भइरहनु र छिमेकी मुलुकसँग पनि प्रतिस्पर्धा गर्नुपर्ने हुनुको साथै लगानी गर्न इच्छुक तेल कम्पनीका सुझावहरुलाई ध्यानमा राखी यस परियोजनाले नेपालको पेट्रोलियम ऐन-नियममा समसामयिक सुधार गर्दैआएको छ । हाल मात्र मलेसियामा सम्पन्न Production Sharing Contract सम्बन्धी Roundtable Conference मा पनि अन्तर्राष्ट्रिय तेल कम्पनीहरुले नेपालको पेट्रोलियम ऐन-नियममा अझ सुधार ल्याउनु पर्ने कुरामा जोड दिएका छन् । ऐन-नियममा समसामयिक सुधार गरिँदै जाने हो भने तेल कम्पनीहरुले अझ पनि नेपालमा कामगर्नसक्ने सम्भावना बढेको देखिन्छ । नेपालको पेट्रोलियम ऐन-नियम बनाउनमा सक्रीय सहयोग दिने नेपाली तथा विदेशी सहयोगी कानूनविद्हरुबाट पनि यस विषयमा समसामयिक संशोधन हुन आवश्यक भएको सुझाव आएको छ । यस तथ्यलाई परियोजनाले पनि महसुस गरी नेपालको पेट्रोलियम ऐन-नियममा थप आवश्यक सुधारगर्नेतर्फ सक्रियता अपनाइसकेको छ ।

विदेशी तेल कम्पनीहरुको संलग्नता

पेट्रोलियम अन्वेषण परियोजनाले नेपाल अधिराज्यको पेट्रोलियम पाइनसक्ने सम्भावित सम्पूर्ण तराई तथा चुरे श्रृङ्खलालाई १० वटा अन्वेषण खण्डहरुमा विभाजन गरेको छ । प्रत्येक अन्वेषण खण्ड करिब ५,००० वर्ग कि. मि. क्षेत्रफलको रहेको छ । अन्तर्राष्ट्रिय तेल कम्पनीहरुले यी १० वटा खण्डहरु मध्ये इच्छित अन्वेषण खण्डमा नेपालको पेट्रोलियम ऐन-नियम भित्र रही बोलपत्र (bid proposal) दिनसक्ने प्रावधान छ । प्राविधिक दृष्टिकोणले नेपालमा तेल तथा प्राकृतिक ग्यास हुनसक्ने सम्भावनालाई अन्तर्राष्ट्रिय तेल कम्पनीहरुले बढी रुचिका साथ हेर्नथालिसकेका छन् । परियोजनाको अथक प्रयास स्वरुप शेल र टाईटन जस्ता अन्तर्राष्ट्रिय तेल कम्पनीले १९८६–१९९० सम्म पूर्वी नेपालको खण्ड १० (विराटनगर) मा अन्वेषण कार्य गरेका थिए । तत् पश्चात् डिसेम्बर १४, १९९८ मा श्री ५ को सरकार र अमेरिकाको Texana Resources Company बीच नेपालको अन्वेषण खण्ड ३ (नेपालगञ्ज) र खण्ड नं. ५ (चितवन)मा ३ वर्षका लागि साइस्मिक तथा भौगर्भिक कार्य गर्ने सम्झौता भएको छ । गत २ वर्षदेखि उक्त कम्पनीले सम्झौता अनुसार प्रथम चरणको अन्वेषण कार्य पनि शुरु गरिसकेका छन् ।

विदेशी तेल कम्पनीहरुको रुचि

नेपालको पेट्रोलियम सम्भाव्यता क्षेत्र तथा Exploration Opportunity बारे बेला-बेलामा परियोजनाले विदेशमा गई प्रचार-प्रसार गर्दै आए अनुरुप अहिले धेरै विदेशी तेल कम्पनीहरु र Service Companies ले नेपाल प्रति चासो देखाउनथालेका छन् । त्यस्तै गरी, भारतका केही ठूला कम्पनीहरुले पनि नेपालमा पेट्रोलियम अन्वेषण कार्य गर्न उत्सुकता देखाएका छन् । नेपालको दक्षिणी सिमानासँग जोडिएको भारतीय भू-भागमा भारतले विगत केही दशकदेखि पेट्रोलियम अन्वेषण तथा ड्रिलिङ कार्यसमेत गर्दै आएको छ भने कतिपय भागहरुमा थप अन्वेषण कार्य गराउन Bid को आह्वान पनि गरिसकेको छ । भारतीय विशेषज्ञहरुले पनि नेपालमा हाइड्रोकार्बन हुने सम्भावना भएको कुरा जनाउँदै आएका छन् ।

डाटा सेन्टर तथा डाटा सेल्स प्याकेज

परियोजनाले हालसम्म सम्पन्न अन्वेषण कार्यहरु तथा यसबाट सङ्कलित डाटाहरुको आधारमा इच्छुक तेल कम्पनीहरुलाई डाटाहरु अध्ययन गर्ने अवसर दिन एउटा Data Centre पनि खोलेको र विदेशी तेल कम्पनीहरुलाई बिक्रीगर्न Data Sales Packages पनि बनाएको छ । तसर्थ विदेशी तेल कम्पनीहरुलाई बेला-बेलामा पेट्रोलियम अन्वेषण कार्यगर्न आकर्षित गराउने उद्देश्यले यस परियोजनाले हरेक वर्ष प्रवर्धन कार्यहरु गर्दैआएको छ । यसको अलावा आफ्नै श्रोत र साधनका साथै विदेशी सहयोगबाट पेट्रोलियम अन्वेषणलाई आवश्यक डाटाहरु सङ्कलनगर्दै निरन्तर रुपमा डाटाहरुलाई अपग्रेड गर्दै लगिएको छ ।

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उपसंहार

नेपाल अधिराज्यमा पेट्रोलियम अन्वेषण तथा प्रवर्धन कार्य क्रमिकरुपले बढाउँदै लैजाने र यस कार्यको लागि नितान्त आवश्यक अन्तर्राष्ट्रिय सहयोग जुटाउन पेट्रोलियम अन्वेषण परियोजनाबाट आगामी वर्षहरुमा अन्वेषण कार्यहरु निरन्तर रुपमा जारीराख्ने कार्यक्रम रहेको छ। श्री ५ को सरकारबाट पनि प्राथमिकता प्राप्त यस परियोजनाको प्रयासले नेपालमा एक दिन आवश्यक तेलको भण्डार पाउन सफलता मिल्ने छ भन्ने आशा गर्न सकिन्छ।

(साभार: प्रभात पत्रिका
नेपाल आयल निगम २०४८)

ABSTRACTS

Nepal Geological Society in close cooperation with the Integrated Studies on Himalayan Uplift and Climate Change Project, Japan; Palaeo-Kathmandu Lake Project, Japan; and Department of Geology, Tri-Chandra Multiple Campus, Tribhuvan University, Kathmandu, organised a one-day workshop on **Himalayan Uplift and Palaeoclimatic Changes in Central Nepal** in Kathmandu, Nepal, on 10 November 2000 (25 Kartik 2057 B. S.). It was attended by over 100 geoscientists from Nepal and Japan. The abstracts of the papers presented in the workshop are given below.

Tectonics and mountain uplift of the Himalaya in Central Nepal

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The Himalayan Mountains and Tibetan Plateau are a series of collisional product between the Indian and the Eurasian continents since Eocene age. The uplift of the Tibetan Plateau is caused mainly by the isostatic adjustment due to crustal thickening caused by the cordilleran-type magmatism before the collision in the southern margin of the Eurasian continent. On the other hand the Himalaya is uplifted by both crustal stacking due to thrust pile after the collision in a fold-and-thrust belt of the northern Indian continental margin and crustal elasticity of the old Indian continent.

The Himalayan orogen consists of several tectono-stratigraphic units bounded by diachronous thrusts younging from north to south namely, the Kangmar Thrust in southern Tibet, the Main Central Thrust (MCT), the Main Boundary Thrust, and the Main Frontal Thrust. These thrust faults are splays off from a major subhorizontal mid-crustal decollement named the Main Detachment Fault (Schelling and Arita 1991) or the Main Himalayan Thrust (Zhao et al., 1993). In central Nepal the thrust tectonics show a southward progagating piggy-back sequence with an out-of-sequence thrust (OST) within the Lesser Himalaya which cuts across the MCT zone and a normal fault around the boundary between the Higher and Tethys Himalayas. Many geochronological data prove the MCT to have been active in the latest Oligocene to early Miocene. The OST may have occurred between 14 Ma and 5Ma (probably 10–7.5 Ma) (Arita et al. 1997).

In order to estimate the denudation rates of the Higher Himalaya and to understand the role of the OST in the Himalayan uplift we performed twenty-three zircon fission-track (F-T) datings of the metamorphic rocks collected at various elevations of the Higher Himalaya and the MCT zone in central Nepal north of the OST and the Paleozoic Palung granites in the Kathmandu Nappe, which thrusts over the Lesser Himalaya along the MCT zone and is located south of the OST. The ages of the Higher Himalayan rocks north of the OST range from 2.3 Ma to 0.6 Ma with exceptions of 3.7 Ma and 7.7 Ma. These ages increase linearly with increasing elevation in each area . The calculated denudation rates based on the assumption of palaeo-geothermal gradient of 35 C/km and zircon closure temperature of 260°C range from 3.2 mm/yr to 12.3 mm/yr over the last 2.3 Ma. The denudation rates increase with time and reach to 12.3 mm/yr over the last 0.6 Ma. The Palung granites south of the OST yield F-T ages of about 9 Ma, giving the denudation rates of 0.8 mm/yr during the last 9 Ma. Gautam and Koshimizu (1991) reported

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three zircon F-T ages of about 2.7 Ma from the Ampipal alkaline complex of the Lesser Himalaya north of the OST. These ages are a little older than the above ages, and accordingly show smaller denudation rates than those from the northern adjacent area.

The clear difference in F-T ages between the rocks north and south of the OST (2.7–1.5 Ma in the north and about 9 Ma in the south) suggest that ramping along the thrust played an important role on the rapid denudation (uplift) north of the OST since the Pliocene. Leveling data across the Kathmandu Nappe between 1977 and 1990 indicate that the uplift rates on the both sides of the OST are quite different; that is, 4–6 mm/yr in the northern side and 2–3 mm/yr in the southern side (Jackson and Bilham 1994). This suggests that the OST also contributes to the recent uplift of the northern area of the OST. According to Pandey et al. (1995), an intense microseismicity is observed along the OST.

Abundant geological and geomorphological evidences suggest that the Himalayan uplift since the middle Miocene started in the Tethys Himalaya, and then shifted southwards. Such a migration of the uplift movement through time is attributed to the southward younging of the thrusting. The uplift since the late Miocene suggested by various points of views is caused by the OST activity. Recent accelerated uplift of the Higher Himalaya in central Nepal may have resulted partly from brittle OST activity in the Lesser Himalaya and partly from the elastic doming beneath the Lesser and Higher Himalayas. The doming has resulted from the fault-bend folding along the ramp of the OST at depth caused by the northward slippage of the Indian crust along the Main Detachment Fault.

Geology and structure of the Panchkhal–Sundarijal area, Central Nepal

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The study area lies in the northeastern margin of the Kathmandu valley. In the area, the Panchkhal valley occupies the central portion whereas the Sheopuri Lekh extends from here to further west. Geological mapping on 1: 25,000 scale was carried out around the Panchkhal Valley and Sundarijal to reveal the structure and tectonic position of the area.

The lacustrine and fluvial Quaternary deposits fill up the Panchkhal Valley whereas the Kathmandu and Nawakot Complexes represent the bedrock. The Kathmandu Complex is thrust over the Nawakot Complex along the Mahabhart Thrust (MT). The main rock types observed in the area are the following.

Kathmandu Complex:

•*Phulchauki Group:*

- Tistung Formation (grey to pale grey sandstone, siltstone, and shale, >1700 m),

•*Bhimphedi Group:*

- Markhu Formation (grey to dark grey, sporadically hornfelsic, calcareous metasandstone, phyllite, and calcareous quartzite with rare marble bands and lenses, 1300 m),
- Kulikhani Formation (grey to dark grey biotite schist and light grey quartzite, 2000 m),
- Chisapani Quartzite (light grey, cream coloured to white quartzite, 400 m),

- Kalitar Formation (dark grey garnetiferous schist and quartzite, 750 m),
- Bhanisedobhan Marble (white, light grey to green-grey coarse-grained and banded marble and schist, 260 m), and
- Raduwa Formation (dark grey and green-grey garnetiferous schist and light grey quartzite, 1200 m).

Nawakot Complex:

- *Upper Nawakot Group:*
  - Robang Formation (Dark grey to green-grey slate and phyllite with amphibolite bands, 150 m), and
  - Benighat Slate (Dark grey to black graphitic slate and phyllite with grey carbonate bands: the Jhiku Carbonates, >1000 m).

The MT is well observed all along its length except at the central part in the Panchkhal Valley where it is covered by the Quaternary deposits. It is characterised by an inverted metamorphism with phyllites and amphibolites of the Robang Formation at the base and the garnetiferous schist of the Raduwa Formation at the top. The MT is gently (20–30 degrees) dipping due SSW and is concordant with the rocks of hangingwall. But the rocks of footwall, which are represented by the Benighat Slate with the Jhiku carbonates, are intensely folded and show discordant relationships with the MT.

There are several bands and 'lenses' of augen gneiss in the Kathmandu Complex. Similarly, the spotted hornfelses are observed in the Markhu Formation in the northern portion. The Sheopuri Gneiss Zone is observed as a swarm of crosscutting pegmatite veins and stringers of several (at least three) generations. It seems that the zone is nothing but a contact metamorphic aureole of a very large intrusive body further north. A schematic cross-section through Ghopte Bhir, Pati Bhanjyang, Kathmandu, Phulchauki and the Marin Khola is also presented to highlight the metamorphism and structure of the area.

Late Quaternary glaciations in Sisne Himal, western Nepal: An implication of the changes of monsoon and westerlies

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Glacial landforms indicate the existence of the past glaciation, and their degree of extension may suggest palaeo-climatic conditions. As widely well known, the Nepal Himalaya is located under the strong summer monsoon environments, and the monsoon precipitation plays an important role in glacier accumulation and fluctuation. Hence, a study about the glacial chronology can reveal the monsoon fluctuations in the Himalayas. However, in western Nepal, the amount of winter precipitation, which is induced by the westerly, is not neglectable on glaciers. The Western Nepal Himalaya is a particularly important region because it marks the junction between the westward summer monsoon and eastward winter westery in the southern flank of the great Himalaya. Hence, the glacial chronological study in western Nepal will lead to understanding the relative importance of the monsoon and westerly since the Last Glaciation.

Sisne Himal, which includes the highest peak of 5,528 m and small mountain glaciers spread in the area, is located 25 km east of Jumla and to the west of Kanjiroba Himal. Extensive evidences of the past glaciation are provided by well-developed glacial landforms such as trough walls and moraines. At least four glacial advance stages can be classified by their geographical positions and weathering criteria of the landforms.

Radiocarbon dating of the bottom layer of peat from the terminus moraine of maximum glacial advance gave the age of 7 ka years, and it may suggest that the maximum extension of glacier occurred in the Last Glacial Maximum (22–18 ka), and it ended not later than 7 ka. Similarly, the date of 5090 yr B. P. was obtained from the peat deposited in the younger moraine. Hence four glacial advance stages can probably be correlated with the Last Glacial Maximum (LGM), early and late sub-stages of Holocene, and the Little Ice Age (LIA), respectively from older to younger order.

Past glacier equilibrium-line altitude (ELA; same as snow line altitude) on each stage was reconstructed based on the dimension criteria. Equilibrium line of LGM and early stage of Holocene shows a southward decline. On the other hand, those of late sub-stage of Holocene, and LIA declined northwards. During Holocene, the direction of glacier equilibrium-line was changed. It may suggest the relative changes in the monsoon and westerly. In earlier, monsoon precipitation had played stronger role on glacier accumulation than those of the westerly. However among the Holocene period, precipitation by westerly was to effect on glacier. Decay of the monsoon or strengthen of westerly could be considered as a factor of the climatic change.

Palaeoclimatic changes during the last 2.5 myr recorded in the Kathmandu Basin, Central Nepal Himalayas

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Palynological and sedimentological studies of a 284-m-long drill core from the Kathmandu Basin reveal palaeoclimatic records and environmental changes in the Kathmandu Valley during the last 2.5 myr. The core is composed of fluvio-deltaic and lacustrine sediments comprising sand beds of 66.3 m and mud beds of 218 m in length. Pollen analyses show *Quercus* and *Cyclobalanopsis* are predominant, with frequencies exceeding 70%. *Pinus*, *Alnus* and Gramineae are the next dominant taxa. Three fossil pollen zones were discriminated, and each zone reflects major climatic change: Zone I in older stage indicates a cool and rather dry climate during 400 kyr from ca. 2.5 to 2.1 Ma. Zone II in middle stage reflects a warm and relatively dry climate without remarkable fluctuation. Zone III is characterised by seven times fluctuation of warm-and-wet and cold-and-dry climate with large amplitude, which reflects repetition of glacial and inter-glacial age.

Sedimentation rate in the open lacustrine environment of the Palaeo-Kathmandu Lake is estimated to be 104 mm/kyr for the last 1.1 myr. The Palaeo-Kathmandu Lake is likely to have been initiated at around 2.1 Ma and to have filled up with black organic mud by the end of the last glacial age. The abrupt appearance of a 4-m-thick fossiliferous sand bed at the top of the middle member suggests that lowering of water level occurred around 1 Ma ago.

Stratigraphy of upper Kathmandu Complex – for the correlation with the proximal Tethys sediments in the Great Himalayas

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During the late Neogene through Quaternary time, the Palaeo-Kathmandu Lake was present in the Kathmandu Valley, which is one of the intermontane basins of Nepal. The basement rocks around the Kathmandu Valley are composed of metamorphic and weakly to non-metamorphosed sedimentary rocks called as the Kathmandu Complex. Concerning the geological history of palaeo-Kathmandu Lake, it is very important to recognise the geological structure and lithostratigraphy of the Kathmandu Complex because the Palaeo-Kathmandu Lake was filled up with the clastic grains derived from the basement rocks around it.

The present author is studying the geology around Mt. Phulchoki and its southward area where the Kathmandu Complex is widely distributed. In this paper, the author presents the stratigraphy of the upper part of the Kathmandu Complex distributed in this area. Furthermore, he shows two stratigraphic problems: one is about the stratigraphic correlation of this rock unit with the Tethys sedimentary series in the Great Himalayas and another is the stratigraphy of its own.

Introduction to Kathmandu Complex

The Kathmandu Complex was first described by Hagen (1969). This complex is distributed in and around the Mahabharat range, central Nepal, and its stratigraphic outline was shown by Stöcklin (1980) and Stöcklin and Bhattarai (1981). According to Stöcklin (1980), the Kathmandu Complex is divided into the Precambrian Bhimphedi Group and the lower to middle Palaeozoic Phulchoki Group by contact of a slight unconformity. The Bhimphedi Group is composed mainly of metamorphic and weakly metamorphosed sedimentary rocks and is subdivided into the 6 formations: the Raduwa, Bhainsedobhan, Kalitar, Chisapani, Kulikhani, and Markhu in an ascending order. The Phulchoki Group is fossiliferous and is composed mainly of non- to weakly metamorphosed sedimentary rocks and is subdivided into the 5 formations: the Tistung, Sopyang, Chandragiri, Chitlang, and Godavari in an ascending order. The Kathmandu Complex forms the Mahabharat Synclinorium and its base contacts with the Lesser Himalayan sediments along the Mahabharat Thrust. In the southern flank of the Synclinorium, there are some granite intrusions into upper Bhimphedi Group.

Stratigraphy of the middle and upper Kathmandu Complex in the study area

In the study area, the upper Bhimphedi Group and the whole Phulchoki Group are widely distributed.

1. The Kulikhani Formation is composed of weathered white quartzose sandstones, green schists and meta-siltstones.
2. The Markhu Formation is composed of coarsely crystalline limestones with intercalation of white to grey meta-siltstones. A large granite body, the Narayanthan Granite, intrudes into this formation.
3. The Tistung Formation is composed of sandstones and siltstones. The lower part of this formation is dominated by dark grey to black meta-siltstones intercalated with light grey fine meta-sandstones. There is a conglomerate bed in the lower part of this formation. The upper part of this formation is rich in light grey sandstones that, in most cases, show reddish colour in weathered surface. Ripple marks are dominant. The contact with the Markhu Formation is conformity and shows transitional change in lithofacies.
4. The Sopyang Formation was recognised in the study area because of the lack of good outcrops.

5. The Chandragiri Limestone is composed of grey argillaceous sandy limestones. Limestones are finely recrystallised. In the lower and upper parts, they are more phylitic and more thinly bedded than that of the middle part. Crinoid fragments occur in the limestone. Ripple marks are common. The contact with the underlying formation is not confirmed in the study area.
6. The Chitlang Formation is composed of siltstones and quartzose sandstones. Some haematite beds, interbedded into siltstones, are accompanied by weathered white quartzose sandstones. Siltstone beds, if there are no haematite beds, show characteristically purple colour. Crinoid fragments are present. The contact with the Chandragiri Limestone is conformity and lithofacies gradually changes throughout the boundary.
7. The Godavari Limestone is composed of limestones, sandstones, and siltstones. The Lower part is composed of fossiliferous bedded limestones showing reddish colour and bearing many marine fossil fauna such as orthoceras, crinoids, brachiopods, and trilobites. The contact with the Chitlang Formation is conformity and lithofacies sharply changes from the alternation of sandstones and siltstones to fossiliferous limestones. The middle part is composed of coarsely crystalline massive limestones showing white, grey, pink, red, and purple in colours. Crinoids are abundant in this limestone. The upper part of this formation is composed of sandstones and siltstones. Sandstones and siltstones yield many ill-preserved crinoid, echinoderm, and brachiopod fragments.

Geological age of the Phulchoki Group

The Phulchoki Group yields many marine fossil fauna. Stöcklin et al. (1977) reported echinoderm fragments indicating middle to late Ordovician age from the Chandragiri Formation and Bordet et al. (1959, 1960) reported marine fossil fauna indicating Silurian age from the Godavari Formation. On the basis of the geological age and the lithostratigraphy, the middle to upper part of the Phulchoki Group is correlated with the Tethys sedimentary series distributed in the great Himalayas.

Correlation with Tethys sedimentary series of the Great Himalayas

There is a normal fault system called as the South Tibetan Detachment System in the great Himalayas. The South Tibetan Detachment System forms a boundary between the Higher Himalayan Crystallines and the Tethys sedimentary series. Therefore, this detachment system is very important in the stratigraphic correlation among the Tethys sedimentary series. The footwall of the detachment system is composed of Sinian to Cambrian system of the Higher Himalayan Crystallines and the hanging walls of that is composed of Lower to Middle Ordovician system of the Tethys sedimentary series. The metamorphic grade of the Sinian to Cambrian system shows greenschist facies if there are no granitic intrusions. On the other hand, the normal fault system has not been found out yet in the Kathmandu Complex. It is necessary to confirm whether the normal fault system in the Kathmandu Complex is present or not for the correlation between this complex and the Tethys sedimentary series in the Great Himalayas.

Stratigraphic relation between the Phulchoki and Bhimphedi Groups

Stöcklin (1980) supposed that the contact between these two groups is a slight unconformity although he described that the lithofacies changed between them. In the study area, the transitional facies change is recognised between them and the conglomerate bed was found in the lower part of the Tistung Formation. These facts indicate that the contact between the Phulchoki and Bhimphedi Groups is conformity and the facies changes transitionally.

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Evidence of a climate change in the Kathmandu basin from Oxygen isotope records

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The Kathmandu basin is a transported intermontane basin from the major Himalayan décollement. The present centripetal drainage pattern shows that the sediments were derived from the flanking metasedimentary rocks on the eastern, southern and western and gneisses on northern side of the Kathmandu Valley. The basin deposits have recorded sedimentation, climatic and tectonic histories during Plio-Pleistocene epoch. Several climatic oscillations have documented from the pollen analysis of the fluvio-lacustrine sediments of the basin (Yoshida and Igarashi 1984).

The present study analyses paleo-climatic change in the Kathmandu basin. Oxygen isotopes were measured in newly formed clay minerals of saprolite sampled from the flanking hill of northern part of the basin, in riverwaters and rainwaters (Galy, unpublished) collected within the Kathmandu Valley and in boigenic carbonate of gasteropod fossil shells taken from the basin fill deposits. The samples collected during the monsoon of 1997 show a homogeneous value of $\delta^{18}O$ between –9 and –12‰ (rain water accumulated in successive precipitation). The oxygen isotopic composition of the riverwaters sampled during out of monsoon time in Kathmandu varies from -7 to –9.4‰. The measurement of $\delta^{18}O$ in saprolite ranges from 16.27 to 16.89‰. The oxygen isotopic compositions of the gasteropod fossils collected from the basin fill deposit in southern part of Kathmandu vary between 28.13 and 29.11 ‰0. From x-ray diffractogram of clay mineral and the stable oxygen isotope studies, it is concluded that a climate change was found those recorded on the corresponding sediments in the southern part of the basin, which was in arid climatic condition in a lake prevailing a strong evaporation.

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Magnetostratigraphy and magnetic susceptibility of lake sediments in the Kathmandu basin

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A magnetic polarity stratigraphy of the valley-filling sediments in the southern part of the Kathmandu basin sediments was established by Yoshida and Gautam (1988). In connection with the ongoing detailed sediments mapping programme carried out by T. Sakai (Kyoto University) under the ISHUCC project of K. Arita (Hokkaido University), it was felt necessary to work out a detailed magnetostratigraphy for the northern part of the basin. For this purpose, oriented samples were collected mainly from the lake sediments belonging to Gokarna, Thimi, Patan Formations and the Pyangaon terrace deposits. Because of the very weak magnetisation intensities, measurements were conducted on a cryogenic magnetometer and the preliminary results indicate that the magnetic polarity is predominantly normal. Detailed work is in progress and a definitive correlation will be possible when additional chronological data (Carbon dating, pollen analytical data) will be available.

Additionally, we measured the magnetic susceptibility of sediment succession in 3 sampling loalities: Gothatar (NE of Tribhuvan International Airport), Nepaltar and Arubari. In all the sections considered, there exists a very good correlation between magnetic susceptibility and sediment particle size. In general, magnetic susceptibility increases with decreasing particle size. The elevated susceptibility values are often associated with silt (including Kalimati) or fine sand. This means that the actual mineral/ crystal dimensions govern the fluctuations in the magnetic susceptibility. The sorting effects of erosion, transportation and sedimentation process can be expected to produce such difference between the magnetic susceptibility of sedimentary layers of differing particle size. The susceptibility may reflect the variations in paleoclimate as well.

Late Quarternary environmental changes on the south face of the Himalayas, deduced from morphoclimatic and morphotectonic features in intermontane basins – preliminary report and prospect

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Preface

We highlight the following two topics. One of them is late Quaternary climatic change related to monsoon fluctuation. Topographic effect of the Himalayas to the global climate change will be discussed through morphoclimatic relicts since the Last Glacial Stage. The other subject is tectonic processes and time scales of the Himalayan morphogenesis. Recent geological researches are going to success to illustrate the outline of the mountain building in mega-years' scale. Relation between the longterm uplift and the present crustal deformation, however, is still an unsettled question. Morphotectonics in kilo-years' scale may help to connect them. Based on the previous studies, we will extend our research area from the Lesser Himalaya to the sub-Himalaya in morphoclimatology, and vice versa in morphotectonics.

Piedmont gentle slopes and deposional surface of lacustrine in the Kathmandu basin

First of all, we notice the relation between the Palaeo Kathmandu Lake and surrounding piedmont gentle slopes. The slopes are composed of thin (less than 10 m) colluvium overlying lacustrine sediments in all locations. The colluvium is poorly sorted sub-rounded or sub-angular gravel in some places and coarse sand with angular gravel in the others. Organic clayey material in the underlying lacustrine was used for radiocarbon dating in order to estimate depositional age of colluvium. The results of the radiocarbon dating indicate that uppermost horizon of those lacustrine deposited around 30,000 yr B. P. (29,200–37,100 yr B. P.). It means that the depositional age of the colluvium, namely period of piedmont gentle slope formation, postdated 30,000 yr B. P. The exact age, however, and environmental conditions under which landslides occurred frequently are still unclear, because no samples suggesting absolute age and palaeoenvironments have been obtained from the colluvium itself. Nevertheless, alternation of organic clay and gravel-rich layer in the lacustrine sediments suggests that the debris supply from back slopes has fluctuated during late Pleistocene in response to cyclic climatic change. Pollen analysis of lacustrine, therefore, is expected to elucidate the relationship between debris supply and climatic change, and palaeo-environments connected with piedmont gentle slope formation can be discussed. Pollen samples from lacustrine should be analysed as soon as possible.

The outer rim of the Kathmandu basin is occupied by a series of lacustrine named the Gokarna Formation that was deposited in the Last Glacial Stage. Judging from the age and the topographic setting, the lacustrine underlying piedmont gentle slopes and the Gokarna Formation can be correlated. It is estimated, therefore, that there was a huge lake covering almost all basin in the Last Glacial Stage. On the basis of the above correlation, following tectonic tendency is estimated. The Gokarna Formation is recognised at the altitude of 1,370–1,390 m in the basin. On the other hand, the altitude of the Gokarna Formation below piedmont gentle slope attains 1,440 m at least. These facts suggest that the Gokarna Formation has deformed due to tectonic uplift after the huge lake disappeared. Such uplift seems to have progressed in harmony with morphostructure around the Kathmandu basin. Namely, it is estimated that the uplift has occurred not only on southern side of the basin but also on northern side. The rate of uplift is roughly calculated to be ca. 2.0 mm/yr.

Basin fills of the Hetauda Dun as indicators of Mosoon fluctuation

The Hetauda Dun is a sub-Himalayan intermontane basin in Central Nepal. The dun is formed as a piggyback basin on the thrust sheet of the Himalayan Frontal Fault (HFF). We suppose that the morphogenesis was resulted from stable slip on the HFF accompanied with decollment that is a boundary between the Indian crust and the Himalayan foreland basin. Results of radiocarbon dating show that the piggyback-basin fills were deposited from 33,000 yr B. P. or older. They are composed of fluvial and swamp deposits. The peaty swamp deposits include pollen fossils. Even though we analyse few samples, which were collected from a layer deposited in the Last Glacial Climax (18,460 yr B. P.), its pollen composition indicates dry and cold environment similar to that of the Kathmandu basin. It implies that climate and vegetation of the Lesser Himalaya and the Sub-Himalaya were controlled under the westerly jet in the Last Glacial Climax. By contrast, the present vegetation in the Hetauda Dun is quite different from that in the Kathmandu basin. Annual precipitation in Hetauda is almost twice of Kathmandu. The humid climate of Hetauda could be explained by effect of orographic rainfall, because Hetauda is just located at the foot of the Mahabhrat Range that is the first barrier to the summer monsoon from the Indian Ocean. These facts suggest that the Sub-Himalayan piggyback-basin fills could be sensitive indicators of monsoon oscillation. We will analyse more pollen samples and attempt to complete pollen diagram in the last 30,000 years. The result can elucidate the monsoon fluctuation from the Last Glacial Stage to Holocene.

Measurement of crystallinity and relative amount of clay minerals in the Kathmandu basin sediments by decomposition of XRD patterns (profile fitting)

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Introduction

Clay minerals represent useful markers of successive climates, since they formed through weathering processes during successive periods of the geological history and basically express the intensity of weathering, especially of hydrolysis, in the land masses adjacent to sedimentary basin. The information provided from such clay minerals fundamentally integrates the combined effects of temperature and precipitation. Many examples of weathering (hydrolysis) processes for the primary minerals (micas, chlorites, feldspars) are provided in the literature.

We can estimate the degree of hydrolysis, if the transformations can be identified and quantified. In general, the development of transformation (1) has been estimated by the crystallinity of the phyllosilicates and that of the other transformations have been shown by the relative amount between the primary and alteration minerals, which can be measured by X-ray diffraction (XRD) experiments.

The Küber crystallinity index which is defined by the full width at half maximum intensity (FWHM) of illite 001 XRD peak has widely been used to estimate the crystallinity of illite. However, recently, Lanson and co-workers demonstrated that XRD peaks for illite and smectite in the 5–11° 2θ CuKα region show not only a difference in FWHM but also a shift in peak position associated with both illite content and mean coherent scattering domain size (CSDS) thickness (illite crystallite). Lanson (1997) also proposed a new illite crystallinity index which accounts for the relative proportion of illite crystallites with low CSDS. The 001 illitic minerals diffraction peak has been observed to be asymmetric. The asymmetry of this peak is in fact due to the existence of several different clay mineral phases. Therefore, Lanson (1997) decomposed the complex 001 XRD bands near 10 Å using three elementary peaks that correspond to three different phases with different illite content and mean CSDS thickness; illite-smectite mixed layer (I-S), poorly crystallised illite (PCI), and well crystallised illite (WCI). The decomposition procedure can be used to fit an XRD pattern with several elementary peaks assumed to represent the respective contributions from the various phases to the total profile.

We have accurately measured the illite crystallinity and relativly amount of the various phases using the decomposition procedure of XRD patterns of clay minerals in the Kathmandu Basin sediments in order to obtain the paleoclimatic information recorded in the sediments. In this session, we report the experimental procedure and the results of the decomposition method of XRD patterns.

Materials and methods

The samples studied are 189 pieces of slime collected at one meter intervals from a drill-well of 284.3 m in depth, located on the bank of the Bagmati River at Balkhu in the western central part of the Kathmandu Basin. The details of the drilled sediments would be described by Fujii and Sakai in other session in this workshop. Until now, 34 samples of the upper part of the drill-well from 5 m to 40 m in depth, which are organic or dark grey mud, have been examined by XRD and the decomposition procedure.

The <2 μm fraction was separated from the whole rock by gravity sedimentation. Then, about 200 mg of this fraction was collected by the Millipore filter (0.4 μm) transfer method (Moore and Reynolds 1989) to provide an optimal orientation, and transferred onto a glass slide. The

thickness of the clay cake is about 15 mg/cm^2, which is adequate for XRD quantitative analysis. The oriented specimens were run on a Rigaku X-ray Diffractmeter RINT 2100V, using CuKα radiation monochromatised by a curved graphite crystal, on both air-dried (AD) and ethylene glycol solvated (EG) preparations which are carried out to expose the sample to the vapour of the reagent over 8 hr at 60° C. Step size and step-counting time were 0.02 degrees and 4 seconds, respectively.

The XRD raw patterns were converted to an ASCII format, transferred to an Apple Power Macintosh 9500/G3-300 computer, and treated with a scientific graphical analysis program of XRD MacDiff V.4.1.2 (Petschick 2000). The profile fitting process was performed according to Lanson and Velde (1992). Basically, the treatment of a raw file begins with a preliminary smoothing to decrease the effect of statistical counting errors. Then, a background is subtracted to eliminate most of its contribution to the peaks. Finally, the elementary peak fitting was done. All decomposition were performed with symmetrical elementary peaks with either Gaussian or Lorentzian shapes. The decomposition for each sample was done four times to check the reproducibility (or error).

Results and discussion

Clay minerals assemblage of this sediments consists of illitic minerals, smectite, illite-smectite mixed layer, chlorite, and kaolinite. Fig. 1 shows XRD patterns in the 3°–11° 2θ CuK$^{\alpha}$ region of AD samples from both 5 m and 31 m in depth, and also shows each Kübler index . Judging from these two Kübler indices, illite in the 5 m depth sample has higher crystallinity than that in the 31 m depth sample. However, these two XRD patterns are different each other, particularly in the relative intensity of illite and smectite (+chlorite) peaks. Smectite (+chlorite) peak intensity is higher in the 5 m depth sample than in the 31 m depth sample. This result on the relative amount of illite and smectite is not consistent with that on the illite crystallinity from Kübler index.

Fig. 1 shows decomposed XRD patterns of Fig. 2 with 5 elementary peaks, smectite, chlorite, I-S, PCI, and WCI. Table 1 lists Lanson index, modified Lanson index, and relative amount between the primary and alteration minerals calculated using the results of the decomposition of the two XRD patterns, as well as Kübler index. We note that the higher Lanson and modified Lanson index values indicate the higher illite crystallinity, reversely in Kübler index. It is clearly shown from the Lanson and modified Lanson indices that illitic minerals in the 5 m depth sample have lower crystallinity than those in the 31 m depth sample. In addition, smectite amount relative to illitic minerals (PCI+WCI) or chlorite in the two samples strongly support this interpretation on the illite crystallinity. These results suggest

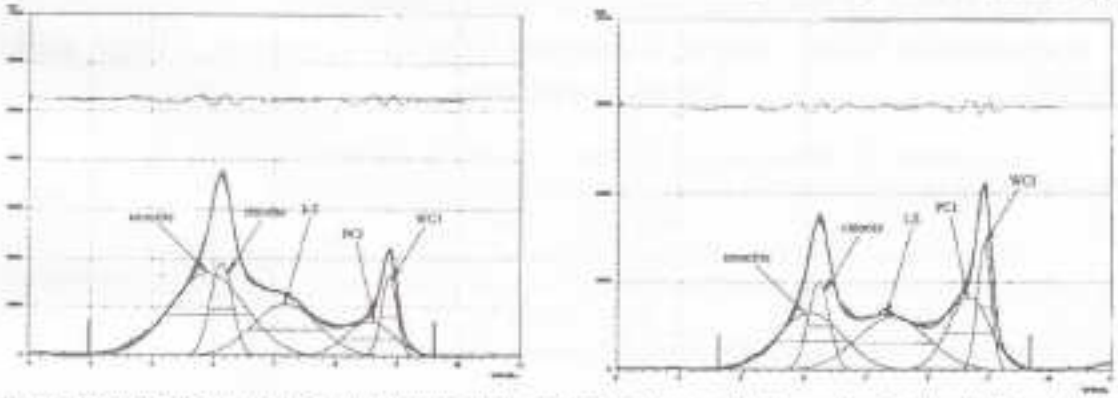

Fig. 1: Decomposition with 5 elementary peaks of XRD patterns of AD samples in the drilled sediments from 5 m and 30 m depths. Dot lines show observed XRD diffraction patterns, solid lines show calculated 5 elementary peaks, bold solid lines indicated calculated XRD patterns combining all elementary peaks, and thin solid lines in upper part of the figures are the difference between observed and calculated XRD pattern.

Table 1: Illite crystallinity indices and relative amount of the primary and alteration minerals, in samples from the depths of 5 and 31 m. Underlined values indicate increasing hydrolysis conditions between the two samples.

Depth	Kübler Index	Lanson Index	Modified Lanson Index	PCI		(IS+PCI)/ (IS+PCI+WCI)	Smectite/(smectite+ PCI+WCI)	Smectite/ (smectite+chlorite)
				Illite Content	CSDS			
5 m	0.397	1.170	0.356	90%	8 layers	0.812	0.742	0.946
31 m	0.415	1.548	0.609	92%	15 layers	0.810	0.307	0.709

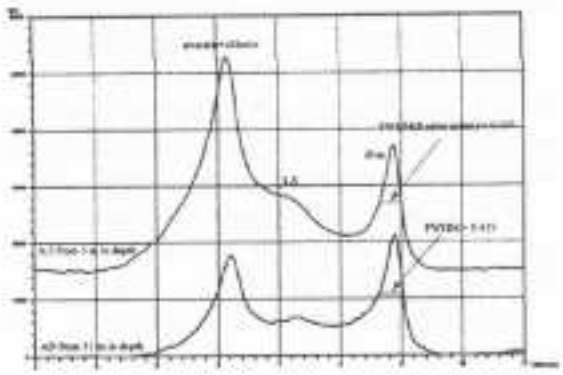

Fig. 2: XRD patterns of AD samples in the drilled sediments from 5 m and 3 m depths. FWHM of illite 001 peak (Kübler indes) are also shown.

that Lanson index is available for the estimation of illite crystallinity and that the estimation of illite crystallinity from Kübler index may not be precise.

We will also report the palaeoclimatic variation recorded in clay minerals in the drilled sediments from 5 m to 40 m in depth.

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Stacking pattern of delta succession in the lacustrine terrace deposits of the Kathmandu Valley, Nepal; examples from the Gokarna, Thimi, and Patan Formations

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The Kathmandu Valley is one of the intermontane basins developed in the Lesser Himalaya and is filled up with fluvial, lacustrine, and delta deposits. According to previous topographic and chronological studies (e.g. Yoshida and Igarashi, 1984), three Late Pleistocene depositional terraces: Patan (ca. 1300 m), Thimi (ca. 1330 m), and Gokarna (ca. 1380 m)

can be discriminated near the central part of the valley. Their formation has been attributed to the lake-level fall of the Younger Kathmandu Lake during the Last Glacial Period (Yoshida and Igarashi, 1984). There has, however, been no systematic study of the basin-fill succession and its relationship to the topographic features. The strata of the terraces were divided into three formations: Patan (11 – 19 Ka B. P; age data compiled by Yoshida and Igarashi 1984), Thimi (24 – 28 Ka B. P.), and Gokarna formations (~ 28 Ka B. P.). Lacustrine delta deposits were recognised in these formations. Here we describe the stacking pattern of delta deposits of each formation focusing, in particular, on the Gokarna, Thimi and Patan formations distributing at the north and the east of Kathmandu City.

The delta successions of the Thimi and Gokarna formations are broadly similar and the major features are as follows:

1. A delta succession, thicker than 10 m, was observed in the lower parts of the both formations. The succession is characterised by aggrading fluvial channel deposits and lateral equivalent aggrading delta front deposits.

2. The upper parts of the formations consist of several delta successions (each 0.5–3 m thick). Minor erosional surfaces punctuate each delta succession and some of them are traceable throughout the whole extent of the formation. Several traceable surfaces define shallow valleys filled with thick sand beds that show convolute lamination. Locally beneath the erosional surface, there is a gravelly sand delta foreset bed changing toward the distal direction into a sand bed exhibiting antidune cross stratification. This type of sedimentary structure is formed under upper flow regime condition.

3. The marginal part of the terrace is incised by small valleys. At the margin of the Thimi Formation, the valley was filled with trough cross stratified gravel beds of braided fluvial channel origin followed by sand or gravel beds with epsilon cross-stratification of meandering channel origin and silt beds with abundant reed roots of flood plain or marsh origin.

The sedimentary features described above suggest that (i) the lake level continued to rise during the accumulation of the lower part of the formation; (ii) the lake-level rise occurred intermittently during the deposition of the upper part. The minor erosional surfaces with shallow valleys and the presence of the antidune cross-stratification just below the erosional surface show that small amplitude but rapid fall of the lake level happened during the terrace formation; and (iii) the presence of the small alluvial fans and the lack of the sediment showing gradual lake level fall imply that the delta accumulation ceased with a large-scale rapid fall in the level of the lake (probably due to large-scale outburst); (iv) overlying meandering channel fill and flood plain deposits show that lake-level rise resumed during the final stage.

The cause of rapid lake-level falls might be related to lake-water outburst into gorges at the exit of the basin. Here, we propose the following delta accumulation model controlled by formation and destruction of a barrier at the gorge-mouth. (I) The gorge was plugged by a landslide or other kind of gravity mass movement. The lake level continuously rose upto the plug level, resulting in the formation of a thick delta succession, which characterise the lower part of the formations. (II) When the lake level reached to the top of the plug, the water level stabilised. Subsequent intermittent lake level rise inducing accumulation of thin delta successions can be attributed to minor landslides occurring along the gorge. Minor lake level fall suggested by shallow valleys was caused by minor lake water outburst. (III) At some stage, a major lake water outburst occurred and the terrace emerged on the land. The terrace margin was incised by fluvial process and small alluvial fans were formed at the foot of the terrace. With renewed formation of a basin plug, the same sequence of events might be repeated.

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The Kathmandu and Gosainkund Crystalline Nappes, central Nepal Himalaya (lithology, structure, metamorphism, geochemistry and radiochronology)

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In central Nepal, a multidisciplinary study has been carried out to characterise and distinguish the crystalline nappes of Kathmandu and Gosainkund from the Midland formations.

Two principal deformations are recorded: one ductile, syn-metamorphic, marked by microstuctures (stretching lineation, S-C structures, etc.), another, post-metamorphic, recorded by an anticline, roughly EW-directed, and by NNE-SSW-directed folds.

The syn-metamorphic (M2) P-T conditions show differences between Kathmandu Crystalline Nappe (900–720 MPa; 700–480° C) and Gosainkund Crystalline Nappe (890–580 MPa; 750–590° C). They exhibit well-preserved inverted metamorphism between the Upper Midland Formations (750 MPa; 560° C) and the Gosainkund Crystalline Nappe.

The augen gneisses and the "Lesser Himalayan" Cambro-Ordovician granites bear similar petrographic and geochemical characteristics which suggest a common origin. However, the geological setting and age of the Proterozoic Ulleri augen gneiss rule out the correlation with this formation.

The U/Pb age obtained on the Nardanda pegmatite shows that the ductile movement along the MCT (contact) between the Kathmandu Crystalline Nappe and Gosainkund Crystalline Nappe is probably blocked since 25 Ma and the movement on the Main Central Thrust (MCT) is transposed on the level of the Mahabharat Thrust (MT) to the south.

$^{40}Ar/^{39}Ar$ analyses of muscovite, indicate cooling ages younging from south to north: 22 to13 Ma in the Kathmandu Crystalline Nappe, 16 to 5 Ma in the Gosainkund Crystalline Nappe, and 12 to 6 Ma in the Midlands. There is no correlation between the ages and the metamorphic assemblages nor the syn-metamorphic deformation. The regular regional distribution of ages from south to north corresponds to a young structure which is related to the late-stage deformation. The older ages in Kathmandu Crystalline Nappe suggest that this nappe was cooled earlier than the Gosainkund Crystalline Nappe.

The principal points summarised by this study are the following:

1. Clear distinction between two nappes marked by their lithostratigraphy and metamorphism,
2. The ductile movement of MCT in the north of Kathmandu is blocked since approximately 25 Ma,
3. The late emplacement and late or common post metamorphic history of the two nappes, but earlier cooling history of the Kathmandu Crystalline Nappe,
4. The present uplift of the Kathmandu region, underlined by the intense microseismosity (Pandey et al. 1995), concerns indifferently the two nappes that form a single tectonic block at present,
5. The combined uplift of the two nappes is due to the displacement on a ramp of major décollement surface.

Finally, both nappes exhibit systematic differences in their composition and geological history. Paleogeographically, Kathmandu Crystalline Nappe began in an intermediate position between the Midlands and Gosainkund Crystalline Nappe (Upreti and Le Fort 1999). The characteristics of the nappes are consistent with a distal origin at the northern edge of the Indian continent.

References

Pandey, M. R., Tandukar, R. P., Avouac, J. P., Lavé J., and Massot, J. P., 1995, Interseismic strain accumulation on the Himalayan crustal ramp (Nepal). Geophys. Res. Lett,. 22, pp. 751–754.

Upreti, B. N. and Le Fort, P., 1999, Lesser Himalayan Crystalline Nappes of Nepal : problem of their origin. Geol. Soc. Am. Bull. Spec. Pap., 328 p.

Rainwater harvesting: its possibility and scope in the Kathmandu Valley

Suresh Das Shresthab[1] and Smita Shrestha[2]

[1]Central Department of Geology, Tribhuvan University, Kirtipur, Kathmandu, Nepal

[2]International Centre for Integrated Mountain Development (ICIMOD), Lalitpur, Nepal

For most of the residents of Kathmandu Valley, living with water scarcity has become a way of life. Municipal water supply is only half of the total water demand. Half of this municipal water supply comes from groundwater sources from the deep aquifers. Total sustainable extraction of the Kathmandu Valley is estimated to be about 26.3 million liters per day. However about 60 % over extraction takes place at present. The result has been a continuous decline in piezometric level which could be catastrophic if the decline of piezometric level continues.

Melamchi Multipurpose Project, a $ 500 million project, is supposed to be the total solution for all the water-related problems in the valley. The project however will take some years to materialise. To cope with the shortage until then, rainwater harvesting may be one of the many possibilities that could be explored.

Since water shortage has become a year-round phenomena now, and groundwater in large volume is extracted even in monsoon season by most of the deep well owners, rainwater harvesting is more feasible now. In many ways, it can be even a better alternative with regards to its quality and almost no need for treatment. The rainwater that is conserved may be even used to recharge groundwater, the possibility that will be studied in the near future.

Evolution of the Neogene fluvial system in the Siwalik Group along the Tinau Khola section,west central Nepal

Prakash Das Ulak[1] and Katsuhiro Nakayama[2]

[1]Department of Geology, Tri-Chandra Campus, Kathmandu, Nepal

[2]Department of Geoscience, Shimane University, Matsue 690-8504, Japan

Based on grain size distribution, nature of bedforms, and sandstone and mudstone ratio mainly six facies associations (TFA1-TFA6) have been recognised in about 4-km thick fluvial succession of Neogene (exposed between the Lesser Himalaya and Indo-Gangetic plain), Siwalik Group along the Tinau Khola section, west central Nepal. These recognised facies associations are closely related to the established lithological units. The Lower and Middle members of the Arung Khola Formation are interpreted as the deposits of the fine-grained meandering system (TFA1), flood flow-dominated meandering system (TFA2) is found in the Upper Member of the Arung Khola Formation. The sandy meandering system (TFA3), deep sandy braided system (TFA4), shallow sandy braided system (TFA5) are well developed in the Lower, Middle, and Upper members of the Binai Khola Formation, respectively whereas the gravelly braided system (TFA6) are found in the Chitwan Formation. All

facies associations are well developed in the south belt, but FA5 and FA6 are absent in the north belt due to the thrust development.

The relation between facies associations and paleomagnetic time frame indicates that flooding increased drastically at 10.0 Ma due to the intensification of the monsoon. The change in a meandering system to braided system occurred at 7.5 Ma and it may be related to the regional tectonic upliftment of the Higher Himalaya. Consequently, the gravelly braided system developed at 2.5 Ma representing regional thrust movement (e.g., Main Boundary Thrust) along the frontal part of the Himalaya.

Tectonics of the Nepal Himalaya: A review

B. N. Upreti
Department of Geology, Tri-Chandra Campus, T. U., Ghantaghar, Kathmandu, Nepal

Today our understanding of the geology and tectonics of the Himalaya have greatly advanced. It was built over works of a large number of geologists for over one and half centuries. Though the Nepal Himalaya has a very short history with only about half a century of systematic geological investigations, pioneering research on most fundamental issues of the Himalayan geology were carried out in this part of the Himalaya. As a result, the Nepal Himalaya is perhaps geologically the most well known part of the Himalaya. Intensive studies were made here on the problems of the inverted metamorphism, tectono-thermal evolutionary history, magmatism, foreland basin development, and seismotectonics and so on.

Despite the above advances in the Himalayan geology, a great deal of uncertainties still exists regarding the basic tectonic framework, origin of the inverted metamorphism and the tectono-thermal evolution of the Nepal Himalaya. A variety of models have been proposed for explaining the famous *inverted metamorphism* of the Himalaya. The issues of the origin and characteristics of the Lesser Himalayan crystalline nappes and their thermal history are yet to be fully understood. The provenance of the rocks of the Lesser, and Higher Himalaya and the crystalline nappes must be well settled.

New techniques in high precision dating of minerals, latest advanced techniques in geochemistry and isotope studies are revealing new and unexpected geological history of the Himalaya. Geochronology, isotope geology, and thermochronometry are becoming invaluable tools in deciphering the intricacies of Himalayan geology. Recently, beginnings have been made in broader age determinations and correlation of the Himalayan rock successions using isotope geochemistry. Similarly, it is becoming an important tool even to precisely delineate the structures like Main Central Thrust (MCT). The rocks on either side of the MCT (Lesser and Higher Himalayan rocks) have been found to have a very contrasting isotopic characteristics which help to differentiate the two different groups of rock.

The MCT is one of the earliest known structures and constitutes the most important master thrusts of the Himalaya. However, even today its definition, precise location and associated thermal history and structures are debated, and a great deal of current research surrounds on these issues. New models regarding inverted metamorphism (which was for long thought to be associated with the movement along the MCT) are being proposed. The question of existence of a thrust below the MCT commonly known as the Lower MCT or MCT 1 has also been the focus of the current studies.

The Kathmandu Nappe is one of the earliest important structures that was recognised in the Nepal Himalaya, and first time the nappe concept was extended to Nepal. Ever since, this nappe has been studied by a large number of researchers

and various interpretations have been proposed. The extent and characteristics of the Kathmandu nappe has been the theme of many recent studies. Recently, this nappe which was thought to be one single unit from the Higher Himalaya to the front of the mountain reaching almost to the Main Boundary Thrust (MBT) is divided into two units. The original Kathmandu nappe has been divided into two: (i) the Gosainkund Nappe in the north with the high-grade metamorphic rocks of the Higher Himalaya and (ii) the Kathmandu Nappe that lies to the south of this nappe and consisting of medium-to low-grade rocks. These two nappes are separated on the basis of the rock units and metamorphic history. The two nappes are separated by the MCT that crops out in the north of the Kathmandu Valley in the Sivapuri Lekh. The Kathmandu Nappe seems to be unique in the entire Himalaya as the medium grade rocks of the Kathmandu nappe (Bhimphedi Group and Phulchauki Group) come in contact with the Higher Himalayan rocks belonging to the Gosainkund Nappe along the MCT. In rest of the Himalayan terrain, the Lesser Himalayan crystalline nappes are separated from the Higher Himalayan rocks by the intervening Lesser Himalayan metasediments.

This paper deals mainly with the existing problems and the status of current research that are going on regarding the tectonics of the central Nepal Himalaya.

Exhumation of Lesser Himalaya deduced from chemical map of garnet in the Annapurna Area, Nepal Himalayas

Haruka Yamaguchi

Department of Complexity Science and Engineering, Graduate School of Frontier Science, The University of Tokyo, Hongo 7-3-1, Tokyo, Japan.

How are the whole orogenic processes, underthrusting to exhumation recorded in the garnet grains? Microstructural observation under the microscope and chemical (EPMA) map analysis revealed the complex relationship between the deformation and metamorphism.

In the studied area, the Annapurna Area of central Nepal, garnet grains show different microstructural features across the Main Central Thrust (MCT), which devides lower grade metamorphic sediments of Lesser Himalayas from higher grade gneiss of the Higher Himalayas. Irregularly outlined garnet of hanging wall show diffusion zoning, whereas double/triple grown garnet and subhedral garnet that contain spiral inclusion trails were observed in the footwall.

In order to correlate the microstructure to metamorphic conditions, inverse petrological method of Gibbs method was applied for the less- to non- diffused garnet grains within the Lesser Himalayas. Spiral inclusion trails that indicate the shear deformation corresponds with increasing pressure (~underthrusting), whereas the inclusion free or non-spiral trailed inclusion part that overgrown this spiral core show increasing temperature. This kind of overgrowth is observed only in the vicinity (under 100 m in thickness) of MCT. Extinct reverse zoning is observed at the very rim of these vicinity garnet grains, which displays extreme decrease of pressure (~exhumation; 4 kb) across the assymetrical truncation, which indicate the breakdown of garnet during the shear deformation.

PARTICIPATION/REPRESENTATION OF NEPAL GEOLOGICAL SOCIETY IN VARIOUS MEETINGS AND ACTIVITIES

Mr. R. K. Aryal, President of NGS, attended **the National Symposium on Managing Disaster: Chisapani Experience** organised by Nepal Red Cross Society on 27 July 2000 in Kathmandu.

Dr. Megh Raj Dhital and Dr. Indra Raj Humagain, members of Nepal Geological Society, took part in a Talk Programme on **Krishnabhir Landslide** organised by the Society of Nepal German Academicians, on September 2000.

Mr. R. K. Aryal, President of NGS, took part in **the Seminar cum Presentation on Inventory of Glaciers, Glacial Lakes and Glacial Lake Outburst Floods Monitoring and Early Warning System** organised by International Centre for Integrated Mountain Development (ICIMOD) and the United Nations Environment Programme/Environment Assessment Programme –Asia and the Pacific (UNEP/EAP-AP) in Kathmandu on 19 September 2000.

On behalf of NGS, Mr. R. K. Aryal, President of NGS, took part in **the Inaugural Ceremony of 7th National Convention of Engineers** on 11 April 2001. The theme of the convention was **Engineering Profession in Nation Building: Contribution and Vision**. Regional Seminar on **Harmonisation of Engineering Qualification: Accreditation and Registration in FEISCA Country** jointly organised by NEA and the Federation of Engineering Institutions of South and Central Asia (FEISCA).

Mr. R. K. Aryal, President, NGS and Mr. K. P. Kaphle, Former President of NGS, attended the Symposium on **Experiences of Natural Disaster/ Earthquake Risk Management** organised by National Society for Earthquake Technolgy–Nepal (NSET-Nepal) in Collaboration with the Institute of Engineering(IOE) Pulchok, Nepal Engineers' Association (NEA), Society of Consulting Architectural and Engineering Firms (SCAFE), and Society of Nepalese Architects (SONA) on the occasion of Earthquake Safety Day – 2001 on January 13–14, 2001 in Pulchok Lalitpur, Nepal.

NEW MEMBERS OF NEPAL GEOLOGICAL SOCIETY

Membership Number	Name	Mailing Address
LM-453	Dr. Birbal Rana	Department of Hydrology and Meteorology, Babar Mahal, Kathmandu
LM-454	Mr. Govind Raj Adhikari	National Institute of Rock Mechanics, Champion Reefs Kolar Gold Fields-563117, Karanataka India
M-455	Mr. Ghan Bahadur Shrestha	Dobhan V. D. C., Dobhan-5, Palpa, Lumbini Zone
M-456	Mr. Prashanta Mahaju	Bhimsensthan Kha 4- 35, Ward No. 20, Kathmandu, Nepal
M-457	Mr. Bishwa Nath Ray Chaudhary	Sundarpur VDC, Udayapur District, Sagarmatha Zone, Nepal
LM-458	Mr. Arun Kumar Ojha	Pink House, Bansbari, Kathmandu
M-459	Mr. Ganesh Mainali	Subidha Nagar, Tinkune, Kathmandu, Nepal
LM-460	Mr. Tara Nidhi Lohani	Udipur-1 Lamjung, Gandaki Zone, Nepal
LM-461	Mr. Surya Prakash Manandhar	Department of Mines and Geology, Lainchaur, Kathmandu, Nepal
LM-462	Mr. Tetsuya Sakai	Department of Geology and Mineralogy, Graduate School of Science, Kyoto University, Kyoto 606-8502, Japan
M-463	Mr. Deb Prasad Jaisi	Tri- Chandra College, Tribhuvan University, Ghantaghar, Kathmandu, Nepal
M-464	Mr. Murari Prasad Kharel	Tri- Chandra College, Department of Geology, Ghantaghar, Kathmandu, Nepal
M-465	Mr. Deepak Chamlagain	Tri- Chandra College, Department of Geology, Ghantaghar, Kathmandu, Nepal
M-466	Mr. Mahesh Singh Dhar	Block-A Naya Basti, Kuleshwor, Kathmandu, Nepal
M-467	Mr. Suman Manandhar	Basantapur, Daisal, Block kha-2-1070, Kathmandu, Nepal
M-468	Mr. Ganesh Nath Tripathi	Gyaneshwar, Kathmandu, Nepal
LM-469	Mr. Samba Prasad Lamichhane	NEA Project Preparation and Studies Department, Durbar Marg, Kathmandu, Nepal

GEOSCIENTIFIC TALK PROGRAMME

Nepal Geological Society has organised the following Geo-scientific Talk Programme during last one-year time on:

(1) A Talk Programme on **Industrial Minerals and Sediments** by Prof. Dr. Habil H.G. Dill from Federal Institute for Geosciences and natural Resources, (BGR) Germany was organised by the NGS on Tuesday, 1st May 2001 (BS 2058/ 1/18) in the auditorium of Department of Mines and Geology, Lainchaur, Kathmandu, Nepal.

(2) Similar Talk Programme on **Geology and Stratigraphy of Kusma–Syangja area** by Dr. Megh Raj Dhital, Reader, Central Department of Geology, T. U., and **Immediate Measures to Mitigate Krishnabhir Landslide** by Dr. Bhagban Das Manandhar was organised on 2 November 2000 (17 Kartik 2057) in the auditorium of Department of Mines and Geology, Lainchaur, Kathmandu, Nepal.

(3) A Talk Programme on **A 3-D Tour for exploring Mars and A Diagenetic Reaction** by Dr. Abhijit Basu was organised on 19 December 2000 (4 Poush 2057) in the auditorium of Department of Mines and Geology, Tri-Chandra Multiple Campus, Ghantaghar, Kathmandu, Nepal.

Members of NGS and other interested personnel attended the above talk programmes.

CALENDER OF EVENTS

* Nepal Geological Society is going to organise **the Third Nepal Geological Congress** on 26–28 September 2001 in Kathmandu, Nepal. The First and Second Circulars of the Congress have already been released and distributed in Nepal and abroad. All the interested geoscientists are requested to fill up the registration form (attached in the Circular) and send to the Convenor alongwith the abstract of their paper before 30 June 2001. All the participants are also requested to submit their full paper before 28 September 2001 to Convenor Mr. R.K. Aryal or Co-Convenor Dr. V. Dangol in P.O. Box- 231, Kathmandu, Nepal. So far response has come over 150 geo-scientists from 10 countries.

Contact Address:
Tel:+997-1-414330;
Fax:+977-1-414806;
E-mail: ngs@wlink.com.np
nepgeosoc@wlink.com.np.
Website: www.geocities.com./ngsnepal

* Andhra University, Visakhapatnam, India is going to organise an International Symposium on **Challenge of Water Resources Management in the Developing countries in the 21st Century** on May 6–10, 2001. Interested person are requested to contact Prof. G. Krishna Rao, Executive Secretary, International Symposium in Dept. of Geology, Andhra University, Visakhapatnam 530 003 India.

Contact Address:
Tel: +91- 891-754871.
Fax:+91-891-755547.
E-mail: geokrsna@mdevanwaters.com.in

* **Landslides–Causes, Impacts and Countermeasures**"organised under United Engineering Foundation Conference Programme in Davos, Switzerland on 17-21 June 2001.

Contact Address:
Fax: +1-212-591-7441.
Email: engfnd@aol.com

* **6th International Course on Community Based Disaster Management** organised by Asian Disasteer Preparedness Center (ADPC) on 2–13 July 2001 at AIT, Bangkok, Thailand.

* The First International Congress on **"Petroleum Contaminated Soils, Sediments and Water"** is going to be held in August 2001 in London, UK. It is going to be organised by Kuwait Foundation for the Advancement of Sciences (KFAS), University of Massachusetts and the Association for Environmental Health and Sciences (AEHS).

Contact Address:
AEHS, 150 Fearing Street Amherst, MA 01002, USA.

* 5th International Conference in Tokyo, Japan, from 23 to 28 August 2001

Contact Address:
Prof. K. Kashiwaya, Dept of Earth Sciences, Kanazawa University, Kanazawa, 920–1192 Japan.
E-mail:kashi@kenroku.kanazawa-u.ac.jp

* **Symposium on Engineering and Development in Hazardous Terrain** Organised by New Zealand Geotechnical Society in University of Cantebury, Centre for Continuing Education, Christchurch New Zealand on 24 – 25 August 2001.

Contact Address:
Fax:+643-364-2057
E-mail: geoetch@cont-canterbury.ac.nz

* **2nd Asian Rock Mechanics Symposium**, Frontiers of Rock Mechanics and Sustainable Development in the 21st Century in Beijing, China on 11–14 September 2001.

Contact Address:
Fax:+86-10-6204-0574.
http://isrm2001.homepage.com

* An International Symposium on the **Assembly and Breakup of Rodinia and Gondwana, and Growth of Asia** is going to be held in Osaka City, Japan on 26–30 October 2001. It is going to be organised by Osaka City University, UNESCO-IUGS-IGCP No.368, 411 and 440. For detail contact Secretariat, ISRGA, Faculty of Science, Osaka City University, 3-3-138 Sugimoto Sumiyoshi-ku, Osaka 558-8585, Japan.

Contact Address:
Tel:+81-6-6605-3184. Fax: +81-6-6605-2604.
E-mail: symp2001@sci.osaka-cu.ac.jp

* **31st IAH Congress**. New approaches to characterising groundwater flow. In Munich, Germany on 10 – 14 September 2001.

Contact: http://agh.iaag.geo.uni-munchen.de

* **2nd Australia – New Zealand Conference on Environmental Geotechnics, Geo-Environment 2001** in Newcastle, Australia on 28–30 November 2001.

Contact Address:
Tel:+61-292-902444.
E-mail: geoenv@icms.com.au

* **American Association of Petroleum Geologists (Annual meeting)**, from 7-10 April 2002, Huston, Texas, USA.

Contact Address:
AAPG Conventions Department, P.O. Box 979,1444 S. Boulder, Ave. Tulsa OK 74101-0979 USA. Tel: +19185602679, Fax: +19185602684
E-mail: dkeim@aapg.org

* **International 18th Himalaya – Karakoram – Tibet Workshop** is going to be held in April 2002 in Sikkim, India.

* **16th International Sedimentological Congress**. July 7–12, 2002, Aukland Park, Gauteng, South Africa.

Contact Address:
Bruce Cairncross Dept. of Geology, Rand African University, P.O. Box 524, Auckland Park, 2006, South Africa. Tel: +27 22 48 91 312. Fax: +27 11 48 92 309.
E-mail:bc@na.rau.ac.za

* **4th International Congress on Environmental Geotechnics**. COPPE-UFRJ in Rio de Janeiro, Brazil on 11–15 August 2002.

Contact Address:
Fax: +55-21-2809545,
E-mail: 4iceg@pec.coppe.ufrj.br

* IAEG is going to organise **9th International Congress on Engineering Geology for Developing Countries** on 16 – 20 September 2002 in Durban, South Africa.

For detail contact:

Organising Secretary, 9th IAEG Congress,
P.O. Box 1283 Westville 3630 South Africa.
Tel: +27-31-2603318.
Fax:+27-31-2602280.
Email:iaeg2002@nu.ac.za

* **Advancing Rock Mechanics Frontiers to meet the Challenges of the 21st Century** in New Delhi, India on 24– 27 September 2002.

Contact Address:

Fax:+91-11-6116347.
E-mail:cbip@nda.vsnl.net.in

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DECORATION AND AWARDS

The 21st General Body Meeting of Nepal Geological Society has decided to honour two distinguished geoscientists: Professor Dr. K. S. Valdia (from Jawaharlal Nehru Centre for Advanced Scientific Research, India) and Dr. Patrick Le Fort (from France) who have contributed a lot on the Himalayan Geology. Their outstanding contributions are highly appreciated by NGS and decided to decorate them with the Honorary Membership of Nepal Geological Society.

CONGRATULATIONS

Nepal Geological Society hearty congratulation to Dr. Tara Nidhi Bhattarai, Member of NGS for his successful completion of the Ph. D. degree in Engineering Geology in 2001 from University, Japan.

RECENT PUBLICATIONS

Books

Review of Policies, Strategies and Activities in Sustainable Development of land and mineral resources in Asia and the Pacific (ESCAP), Mineral Resources Assessment, Development and Management series, Volume 6, 2000.

Mitigation and Management of Flood in Nepal – 2000 by Meen B. Poudyal and Damodar Bhattarai 2001.

Integrated Assessment and Development of Mineral Resources in the Greate Mekong Subregion, Vol.II/ ESCAP 1999. Mineral concentrations and hydrocarbon accumulations in the ESCAP Region

Structural Geology: A Practical Guide to Surface and Subsurface Map Interpretation. Textbook by R. H. Groshong, Springer, 1999, 320 p., ISBN 3540654224, Price DEM 129.00

Analytical Solutions of Geohydrological Problems by G. A. Bruggeman. Elsiver, 1999, 970 p, ISBN 0444818294, Price US$ 465.00

Cambridge Guides to Minerals, Rocks and Fossils. by A. Woolley et al. Cambridge University Press, 1999. 336 p., ISBN 0521778816, Price US$ 14.95

Earth Science and Environment (2nd edition) by Graham R. Thompson, Saunders College Publishing, 1999, ISBN 0030060486

Earthquake Geotechnical Engineering (Proceedings of the 2nd International Conference, Lisbon, Portugal, 21–25 June 1999, 3 Vols.) by P. Secoe Pinto., A. A. Balkema, 1100 p., ISBN 9058091163, Price US$ 215.00

Environmental Assessment Practice Guide by Barbara Carol and Trevor Turpin, Thomas Telford Ltd. 1999, 150 p., ISBN 0727727818, Price UKL 20.00

Flood and Landslide: Integrated Risk Assessment (Environmental Science), edited by R. Casale and C. Margottini, Springer, 1999, 450 p., hardback, UKL 96.00, ISBN 3540649816, Price DEM 249.00

Geostatistics in Petroleum Geology by Oliver Du Burle, Continuing Education Course Notes #38, Cat. #908, the American Association of Petroleum Geologists, 1998, ISBN 0891811877, Member Price US$ 24.00, List price US$ 30.00

Geostatistics for Engineers and Earth Scientists by R. A. Olea. Kluwer, 1999, 328 p., ISBN 0792385233, Price NGL 280.00

Geostatistics for Environmental Scientists by R. Webster and M. A. Oliver, John Wiley, 1999, 442 p., ISBN 0471965537, Price US$ 76.50.

Geotechnical Engineering: Principals and Practices by Donald, P. Coduto, Prentice Hall, 1999, 750 p., hardback, ISBN 013576380, Price US$ 110.00

Groundwater Pollution Control edited by K. L. Katsifarakis, WIT Press, 1999, apx 350 p., ISBN 1853126756, Price UKL 112.00

Hydrogeology and Engineering Geology of Sinkholes and Karst. (proceedings of the 7th Multidisciplinary Conference on Harrisbug Hershey. PA.USA. 10–14 April 1999) edited by Barry F. Beck et al., A. A. Balkema, 1999, 480 p., hard back, ISBN 9058090469, Price US$ 115.00

On the Determination of Sediment Accumulation Rates (Georesearch Forum Volume 5) edited by P. Bruns and H. C. Hass., Trans. Tech. Publications Ltd., 1999, 256 p., ISBN 0878498370, Price UKL 58.00

Slope Stability by Anderson., John Wiley, 1999, ISBN084934106x, Price DEM 108.00

Soil Mechanics and Geotechnical Engineering (Proceedings of 11th Asian Regional Conference, Seoul, Korea, 16–18 Aug. 1999) edited by Sung-Wan Hong, A. A. Balkema, 1999., 2 vols., 900 p., Price US$ 85.00

Soil Mechanics and Geotechnical Engineering (Proceedings of 12th African Regional Conference, Durban, 25-27 Oct. 1999), edited by Peter Day, A. A .Balkema, 1999, 3 vol., 1200 p., ISBN 9058090825, Price US$ 152.00

Mineralogy Tutorials: Interactive instruction on CD-Rom Version 2.0 by C. K. Lein, John Wiley, 1998, Price US$ 49.95.

Journals

Journal of Nepal Geological Society, Volume 21 is already published in 1999 and is in circulation.

Journal of Nepal Geological Society, Special Issue, Volume 22 (Proceedings of International Symposium on Engineering Geology, Hydrogeology, and Natural Disasters with Emphasis on Asia) is already published in December 2000 and is in circulation.

Journal of Nepal Geological Society Volume 23 is in the process of publication.

NOTICE

All the members of NGS and other interested persons and institutions are requested to get the Journals volumes 2, 3, 4, 5, 6, 7, 8, 9, 10 (old issues) in special 50% discount price. All the members are requested to take the opportunity in purchasing the journals.

Journal of NGS vol 22 Special Issue (Proceedings of International Symposium on Engineering Geology, Hydrogeology, and Natural Disasters with Emphasis on Asia) is published. Hurry up to purchase this precious volume.

All the members of NGS are requested to take part in the Third Nepal Geological Congress which is going to be organised by Nepal Geological society on 26–28 September 2001 in Kathmandu, Nepal.

BIO-DATA OF HONORARY MEMBERS OF NGS

K. S. Valdiya

Date of Birth: 20 March 1937

Nationality: Indian

Permanent Address: Nainital of Kumaun District, India

Education:

1955	M. Sc. in Geology, Lukhnow, India
1959	Ph. D. Lukhnow, India

Academic Performance:

1957–1969	Lecturer in Geology, Lukhnow University
1969–1970	Reader in Geology, Rajesthan University, Udaipur
1970–1976	Senior scientist, Deputy Director, and additional director Wadia Institute of Himalayan Geology, Debradun, India
1976–1995	Professor and Head of the Department of Geology, Kumaun University
1981, 84, and 92	Vice Chancellor, Kumaun University

Present Position:

* President, Wadia Institute of Himalayan Geology Delhi.
* Professor of Geodynamics at the Jawaharlal Nehru Center for Academic Scientific Research, Bangalore, India.

Research:

* With more than fourty years of research and teaching experience;
* Published more than ninety research papers and popular articles in National and International Journals on Himalayan Geology;
* Published four text books on Himalayan Geology;
* Edited Volumes 4; and
* Monographs 2.

Awards:

1991	S. K. Mitra Award of the India National Science Academy
1993	National Mineral Award of the Ministry of Mines, Government of India
1995	D. N. Wadia Medal of the Indian National Science Academy
1982–84	Pitambar Pant National Environment Fellow, Ministry of Environment and Forests, Government of India
1977–78	National Lecturer of University Grant Comission
1980	L-Ram Rao Goldmedal of Geological Society of India
1976	Bhatnagar Prize of Council of Scientific and Industrial
1976	Research
1957	Chancellors Medal at Lukhnow University

Fellowship:

* Third World Academy of Science (Trieste, Italy)
* INSA (India National Science Academy), Delhi
* Indian Academy of Science (Bangalore)
* GSI (Geology Society of India)
* Life Member (LM), Nepal Geological Society (NGS)
* NAS (National Academy of Science, Bangalore.

Patrick Le Fort

Date of Birth: 8 December 1939

Nationality: French

Permanent Address: Lille, France

Education:

1962	Engineering Geologist, Nacy, France
1971	D. Sc. (Natural Science) Nacy, France

Professional Experience:

* Research Scientist, CNRS, France in 1962
* Research Director CNRS, France
* Visiting Professor, Harvard University in 1973–1974
* Member, French National Committee of Geology
* Co-organiser and organiser of HKT and various International Symposium
* Editor of tectonophysics (1986–1992) and many of the Himalayan and Asian Geological Journals
* Scientific Leader of more than 20 geological expeditions (Greece, Himalaya, Korakorum, IDYLHIM etc.)

Present Position: Scientific and Development Councillor Embassy of Republic of France, South Africa.

Research activities: Has done research on metamorphism, magnetism, and tectonogenesis of the mountain belts of Alps, Himalaya, Karakorum, Hindu Kush, Zagros, and Poutides regions.

Publications:

* 10 important publications on Himalayan tectonic evolution and metamorphism and magnetism
* More than 135 scientific research papers on metamorphism, granite and geotectonic studies.

Awards: Silver Medal of the CNRS (1975)

Manpower training:

Ph. D. (two persons)
M. Sc. (one person)

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